Vol. III. Price, 7s. 6d. Part 3.

Bothalia

A RECORD OF

CONTRIBUTIONS

FROM THE

NATIONAL HERBARIUM

UNION OF SOUTH AFRICA

PRETORIA

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PUBLISHED APRIL, 1938.

G.P.-S.6921—1937—1,000.

CONTENTS.

THE USTILAGINALES OF SOUTH AFRICA.

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The following paper is an attempt to monograph partially the smuts or Ustilaginales of South Africa and adjacent territories. Besides species found wholly within the Union of South Africa, there are included species from South West Africa, Portuguese East Africa, the Tanganyika Territory, Rhodesia and Nyassaland Protectorate.

Original descriptions of South African smuts are to be found in various publications, principally German. Paul Hennings and later the Sydows have described most of the new species found in South Africa. Recently the author has described new species of South African smuts.

In 1926, Len Verwoerd of the University of Stellenbosch made the first attempt at monographing South African smuts. It is the hope of the writer that sometime in the future he will be able to enlarge and complete the present paper as more specimens are collected and become available. Specimens used for descriptions in the present paper are mostly from the Mycological Herbarium, Union Department of Agriculture. Many type specimens of species described herein were not available for examination, in fact the writer has not been able to locate the type specimens of some of the very early South African collections.

Acknowledgment and thanks are hereby made to the Director of the Royal Botanic Gardens, Kew, Surrey, England, for supplying type material of *Tilletia Ayresii* Berk. for study; to Miss Claribel Barnett, Librarian, and Mr. J. A. Stevenson, Mycologist, both of the United States Department of Agriculture for furnishing original descriptions of some of the species and for the loan of books; to Dr. George Perkins Clinton for the loan of type specimens from his personal herbarium. The genus descriptions have followed very closely, in some cases verbatim, those previously published by Dr. Clinton. Dr. Robert E. Dengler, Professor of Classical Languages, The Pennsylvania State College, has kindly written the Latin descriptions of new species. The host identification and nomenclature have been revised according to the latest usage by Miss L. Chippendall of the South African National Herbarium, Pretoria.

The asterisk (*) after a host plant name or locality indicates that the record has been secured from literature and that no specimen has been seen.

CHARACTERIZATION OF THE USTILAGINALES.

This group of fungi belongs to the sub-group Hemibasidiomycetes with the single order Ustilaginales containing two families: (1) Ustilaginaceae, and (2) Tilletiaceae.

The Ustilaginales consist of nearly 600 species. All of them are obligate parasites usually attacking herbaceous plants. The mycelium is internal, slender, hyaline, somewhat septate and branched. It is either uninucleate, binucleate or occasionally multinucleate.

The hyphae are usually intercellular with capitate or racemoid haustoria penetrating the host cells for food. Most of the smuts attacking cereals, however, have intercellular mycelium without haustoria and obtain food direct from the host cells by the process of osmosis. A third class of smut fungi, e.g. *Ustilago Zeae*, has mycelium that penetrates the individual host cells causing death.

At maturity the hyphae enter certain organs of the host and form thick celled chlamydospores which are the common smut spores or winter spores. These are produced singly, in pairs or in balls, usually forming a dark powder at maturity. In the genera *Entyloma*, *Tracya*, *Burrillia*, and *Doassansia*, however, the spores are produced within the host tissues and are light coloured. In the early stages of development, all of the spores are binucleate. At maturity each spore is uninucleate but is produced from a binucleate hypha. Each mature spore has a thin endospore and a thicker variously colored and sculptured exospore. At maturity the spore masses produce various effects on the host, e.g. a shredding of the leaves of the host ; a destruction of the inflorescence ; the replacing of the pollen by smut spores and the utilization of the pollen distributing apparatus for the distribution of smut spores ; stimulating the development of staminoids in pistillate flowers ; the formation of boils or gall-like tumor growths ; the destruction of the seed, etc.

Usually the mycelium is annual, however, in some cases it is perennial and hibernates in the roots of the host.

The Ustilaginales are divided into two families based on the method of producing the promycelium and basidiospores. In both families, previous to the production of a promycelium, the nucleus divides and one of the daughter nuclei leaves the interior of the spore and migrates into the promycelium.

The first family is the Ustilaginaceae. Here the daughter nucleus in the primary promycelium divides twice forming four nuclei. Following these divisions three septa, or cross walls, are formed thus forming a four celled promycelium. Basidiospores are produced laterally at the cross walls. As the basidiospores are formed, the nucleus in the promycelial cell divides and one migrates into the basidiospore. This process continues as long as basidiospores are produced. The infection tubes are produced by the basidiospores.

The second family is the Tilletiaceae. As the promycelium develops, one of the daughter nuclei together with some of the protoplasm migrates from the interior of the germinating spore into the base of the young aseptate promycelium. This is followed by at least four and sometimes more nuclear divisions, thus forming at least eight nuclei which together with the protoplasm migrate to the distal end of the mature promycelium. The lower empty part of the promycelium is then cut off by three septa. Eight basidiospores are then produced terminally and usually conjugate before separation from the promycelium.

Conjugation seems to be necessary in order for the smut fungus to infect its host plant, i.e. there are apparently basidiospores and promycelium cells with two genders. The conjugation process may take place in any of the following ways :—

(1) A basidiospore may conjugate with another basidiospore.

(2) A basidiospore may conjugate with a cell of a promycelium.

(3) A promycelium cell may conjugate with another promycelial cell.

(4) Occasionally two promycelia are produced from one smut spore and promycelial cells of one promycelium may conjugate with cells of the other promycelium.

Infection tubes are produced by the conjugated parts of the basidiospores or promycelia. There are three principal types of infection :—

Type 1. The chlamydospores attach themselves to the seed of the host and do not grow until the host seed germinates. In this manner there is a seedling infection. The germ tube penetrates the tissues of the entire host plant.

Type 2. The chlamydospores attach themselves to the stigma of the flower of the host, where they germinate at once, sending mycelial threads down the style into the young ovary where the mycelium becomes dormant without deforming the seed, and resting there until favorable conditions for seed germination arrive. As the seed germinates and grows, the dormant hibernating mycelium becomes active and penetrates the entire host tissue, finally replacing the inflorescence with smut spores.

Type 3. In this type the chlamydospores produce promycelia and basidiospores in decaying vegetation. The basidiospores are then carried by the wind to the young host plants where local infection takes place. The mycelium penetrates the host cells only locally.

During the short time of basidiospore formation, the smuts are facultative saprophytes forming colonies of yeast-like sporidia. Most of them can be cultivated on nutrient agar but few if any can complete their life history on artificial media.

CLASSIFICATION OF THE USTILAGINALES.

The Ustilaginales are parasitic fungi that attack various parts of herbaceous plants. Infection nearly always takes place through very young tissues, either through germinating seed or other special parts of the host. This group can usually best be recognized by the sooty mass of spores that are produced, singly, in pairs, or as spore balls. The black smuts are represented by such genera as *Ustilago, Sphacelotheca, Sorosporium, Urocystis* and *Tilletia*, while the so-called white smuts are mostly leaf inhabiting and are included in such genera as *Burrillia*, *Doassansia*, *Entyloma* and *Tracya*.

Two families are included in the order Ustilaginales, (1) the Ustilaginaceae, and (2) the Tilletiaceae. They are separated by the manner in which the promycelium and sporidia are produced as follows :—

Promycelium usually with lateral sporidia at septa . . . Ustilaginaceae.

Promycelium with clustered terminal sporidia. . . . . Tilletiaceae.

In the classification of the smut fungi the viewpoint is held that morphological characters rather than host susceptibility or the use of biometry must be the basis for determining species. The concept of species as used in this paper is very broad. Many recently described species are merely physiological or pathological strains that have adapted themselves to specific hosts. Such species should be relegated to synonymy.

Within the last few years technique has been perfected whereby it is now possible to hybridize the smut fungi and thus study gender and species relationship as is done in the higher plants. Extensive work of this nature has been done by workers in the United States Department of Agriculture and of the several state Agriculture Experiment Stations, also by workers in Canada and Wales. A brief summary of a few of the numerous papers follows :—

Reed[1] in 1928 reported four physiological races of *Tilletia laevis* and six physiological races of *Tilletia Tritici*. Each physiological race varied in its ability to attack different varieties or even strains within a given variety of wheat.

Flor[2] working in Washington State reported in 1932 that *Tilletia Tritici* and *Tilletia laevis* were heterothallic. He also reported that he hybridized *Tilletia Tritici* and *Tilletia laevis* and had obtained evidence that hybridization occurred in nature. Examination of over 10,000 bunted heads revealed that there were all degrees of reticulations on spore

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[1] Reed, George M. Physiological races of wheat bunt. Am. Jour. Bot. **15** : 157–170. 1928.

[2] Flor, H. H. Heterothallism and hybridization in *Tilletia Tritici* and *T. laevis*. Jour. Agr. Res. **44** : 49–58. 1932.

of *Tilletia Tritici*. In some cases the reticulations were so fine that it was almost impossible to see them ; on the other hand the reticulations were so coarse that they appeared almost spiny.

In 1924, Faris[3] showed that there was physiological specialization of *Ustilago Hordei* and that each physiologic form attacks only certain specific varieties of barley.

Holton[4] in 1932, reported that he had hybridized *Ustilago Avenae* and *Ustilago levis*. He found that factors such as echinulation of spores, growth of the fungi in artificial culture, appearance of the smut in the panicle, all followed in general a Mendelian ratio and furthermore a buff colored smut with hyaline spores was produced by crossing monosporidial lines hybrid chlamydospores. Later he found[5] that the buff smut resulted from a mutation in *Ustilago levis*. He further found that pathologic strains of *U. Avenae and U. levis* were produced by hybridization and segregation.

In a more recent paper,[6] Holton reported that when *U. Avenae* and *U. levis* were hybridized that (1) the factor for brown is dominant over the factor for hyaline chlamydospores ; (2) the factor for echinulate spore walls is dominant over the factor for smooth spore walls and that these characters generally segregate in a Mendelian ratio.

Reed and Stanton[7] in 1936, reported that a distinct strain of loose smut (*U. Avenae*) occurs on Red Rustproof oats. This strain of smut also attacks various strains of *Avena fatua* and *Avena strigosa*, also the variety Canadian (a variety of *Avena sativa*).

Rodenhiser[8] working with *Sphacelotheca Sorghi* and *Sphacelotheca cruenta* found physiologic forms in both species. He produced an intermediate type of smut by hybridizing *S. Sorghi* and *S. cruenta* which had a sorus different from either parent with two kinds of sterile cells, the small sterile cells of *S. Sorghi* and the large spherical type of *S. cruenta*. In culture, numerous mutants were observed to arise. It was possible for him to produce new physiologic forms by hybridization and segregation.

In view of these results it seems that H. Sydow[9] in 1924, when he made a study of *Cintractia Caricis* (Pers.) P. Magn. on *Carex* spp., and finally described ten new species based on host species, had in reality only ten physiologic forms of *Cintractia Caricis* (Pers.) P. Magn. that by natural hybridization and segregation were pathologic to specific species of *Carex*.

Likewise Liro[10] in 1924 in his study of the smuts attacking *Polygonum* spp. and Ciferri[11] in 1928, in his new sub-species of *Entyloma compositarum* Farlow are dealing with physiological forms.

Fisher[12] has recently reported the natural infection of *Agropyron tenerum* in central Washington by *Tilletia Tritici* and notes that the size of the sorus varies with the size of the ovary of the host. In other words, the morphology of the fungus varies with the host.

[3] Faris, James A. Physiologic specialization of *Ustilago Hordei*. Phytopath. **14** : 537–557. 1924.

[4] Holton, C. S. Studies in the genetics and the cytology of *Ustilago Avenae* and *Ustilago levis*. Univ. Minn. Exp. Sta. Tech. Bull. **87** : 1–34. 1932.

[5] Holton, C. S. Origin and production of morphologic and pathologic strains of the oat smut fungi by mutation and hybridization. Jour. Agr. Res. **52** : 311–317. 1936.

[6] Holton, C. S. Inheritance of chlamydospore characters in oat smut fungi. Jour. Agr. Res. **52** : 535–540. 1936.

[7] Reed, George M. and Stanton, T. R. Reaction of oat varieties to physiologic races of loose and covered smuts of red oats. Jour. Agr. Res. **52** : 1–15. 1936.

[8] Rodenhiser, H. A. Studies on the possible origin of physiologic forms of *Sphacelotheca Sorghi* and *S. cruenta*. Jour. Agr. Res. **49** : 1069–1086. 1934.

[9] Sydow, H. Notizen über Ustilagineen. Ann. Myc. **22** : 277–291. 1924.

[10] Liro, I. J. Die Ustilagineen Finlands. I. Ann. Acad. Sci. Fenn. A. **17** : XVIII—636 pp. 1924.

[11] Ciferri, R. Quarta contribuzione allo studio Ustilaginales. Ann. Myc. **26** : 1–68. 1928.

[12] Fischer, George W. The susceptibility of certain wild grasses to *Tilletia Tritici* and *Tilletia laevis*. Phytopath. **26** : 876–886. 1936.

KEY TO GENERA OF USTILAGINALES REPORTED FROM SOUTH AFRICA.

I. Spores single :—

A.—Usually forming a dusty sorus at maturity—

1. Large, usually 15–35 μ .... *Tilletia.*
2. Small to medium, usually 5–18 μ—
   (*a*) Sorus covered with a false membrane of fungoid cells... *Sphacelotheca.*
   (*b*) Protecting membrane, if any, of plant tissue .... *Ustilago.*

B.—More or less firmly agglutinated at maturity—

1. Firmly agglutinated into irregular nodules .... *Melanopsichium.*
2. Developed around a central columella (rarely becoming dusty) *Cintractia.*

C.—Imbedded in leaves at maturity—

1. Usually hyaline or light colored .... *Entyloma.*

II. Spores in more or less regular balls :—

A.—Forming a dusty or granular sorus at maturity—

1. Spore balls consisting only of fertile cells—
   (*a*) Usually evanescent, olivaceous or black brown .... *Sorosporium.*
   (*b*) Quite permanent, spores adhering by folds of outer coat *Tolyposporium.*
2. Spore balls with outer sterile cortex .... *Urocystis.*

B.—Implanted in plant tissue at maturity—

1. Spore balls without definite cortex or sterile cells .... *Tuburcinia.*

Family I.—USTILAGINACEAE.

Ustilago (Pers.) Roussel[13], Fl. du Calvados ed. 2. 47. 1806.
Necrosis Paulet, Traite Champ. **1** : 584. 1793.
Ustilago Pers. Syn. Fung. 224. 1801. (sub-genus.).
Ustilagidium Heré. Zopf Beitr. Phys. Morph. Org. **5** : 7. 1895.

Sori on various parts of the hosts, at maturity forming dusty, usually dark colored spore masses; spores single, produced irregularly in the fertile mycelial threads which early entirely disappear through gelatinization; small to medium in size; germination by means of a septate promycelium producing only infection threads or with sporidia formed terminally and laterally near the septa; sporidia in water usually germinating into infection threads but in nutrient solutions multiplying indefinitely, yeast fashion.

Type: *Ustilago segetum* Pers., on Gramineae, France.

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[13] Clinton, N. Am. Flora **71** : 3. 1906, points out that " J. Bauhin, Hist. Pl., 418, 1651, is really the founder of *Ustilago*. Fries or Persoon is ordinarily cited as authority for the genus. Fries used *Ustilago* as a genus in his Syst. Myc., **3** : 517. 1832, with *U. grandis* as the first species. Persoon used *Ustilago* as a subgenus under *Uredo* with *Uredo segetum* as the first species, having five varieties of which *U. Hordei* is first, and this may be taken as the actual type now that *U. segetum* has been broken up into several species. Roussel merely adopted *Ustilago* from Persoon, but raised it to full generic rank, giving three of Persoon's four species, of which *U. segetum* is one. Paulet's name, *Necrosis*, cannot be regarded as a true generic name, but was used more as a descriptive term."

* Spores smooth.

Ustilago Elionuri P. Henn. and Pole-Evans, Bot. Jahrb. (Engler) **41** : 270. 1908

Sori in the ovaries, 1-1.5 cm. long, covered with a dark-brown membrane of host tissue which dehisces apically revealing a semi-agglutinated brown spore mass; spores globose—ellipsoidal, irregular, somewhat angled, dark olive-brown, 5-7 μ diam., smooth under oil immersion.

Type host and locality: On *Elionurus argenteus* Nees, Pretoria, Transvaal, Union of South Africa.

On Andropogoneae: *Elionurus* (*Elyonurus*) *argenteus* Nees, Transvaal.[1] (M.H. 102, 9316, 17268.)

Distribution: Transvaal and Argentina.

Ustilago Hordei (Pers.) Lagerh.[2] Mitt. bad. bot. Ver. 70. 1889.

Reticularia segetum Bull. Hist. Champ. *pl.* 472, *fig. II.* 90. 1791.

Uredo segetum Hordei Pers. Tent. Disp. Fung. 57. 1797.

Uredo carbo DC. Fl. Fr. **6** : 76. 1815. p.p.

Ustilago segetum Link, Ditm. in Sturm's Deutsch. Fl. III. **1** : 67. 1817. p.p.

Caeoma segetum Link, Willd. in Sp. Pl. **52** : 1. 1825. p.p.

Erysibe vera Hordei Wallr. Fl. Crypt. Germ. 2 : 217. 1833. p.p.

Uredo Carbo-Hordei Phillipar, Mem. Soc. Roy. Agr. Arts, Seine-et-Oise **37** : 195. 1837.

Ustilago Carbo vulgaris Hordeacea Tul., Ann. Sci. Nat. Bot. III. **7** : 80. 1847. p.p.

Ustilago segetum var. *Hordei* f. *tecta* Jens. Om Korns. Brand. **61** : 1888.

Ustilago tecta hordei Jens. Charb. Cereals 4. 1889.

Ustilago hordei Kell. and Sw. Ann. Rep. Kans. Agr. Exp. Sta. **2** : 268. 1890.

Ustilago Jensenii Rostr. Overs K. Danske Vid. Selsk. Forh. **1890** : 12. 1890.

Sori in the spikelets, destroying the inflorescence, forming a rather permanent purple-black spore mass covered by a permanent membrane, about 5–8 mm. long: Spores globose-subglobose, occasionally ellipsoidal, olivaceous-brown, 5–7 μ diam. or slightly larger, smooth.

Type host and locality: On *Hordeum vulgare* Linn., Europe.

On Hordeae: *Hordeum vulgare* Linn., Cape Colony, Transvaal, Orange Free State. (M.H. 1181, 7080, 9823.)

Distribution: Co-extensive with the cultivation of barley.

Ustilago levis (Kell. and Sw.) P. Magn. Abh. Bot. Ver. Prov. Brandenburg **37** : 69. 1896

Ustilago Avenae var. *levis* Kell. and Sw. Ann. Rep. Kansas Agr. Exp. Sta. **2** : 259. 1890.

Ustilago Kolleri Wille, Bot. Notiser **1893** : 10. 1893.

Sori in spikelets, more or less destroying basal and inner glumes; spores globose-subglobose, light olivecaous-brown, usually lighter colored on one side, 5–7 μ diam., sometimes slightly larger, smooth.

Type host and locality: On *Avena sativa* Linn., Kansas, United States.

On Aveneae: *Avena sativa* Linn., Cape Colony, Trnasvaal, Rhodesia.* (M.H. 538, 940, 7094, 8352, 10971.)

Distribution: Co-extensive with the cultivation of oats.

Ustilago affinis Ellis and Ev. Bull. Torrey Club **20** : 297. 1893.

Ustilago Hilariae P. Henn. Hedwigia **37** : 267. 1898. Not *Ustilago Hilariae* Ellis and Tracy, 1890.

Ustilago Stenotaphri P. Henn. Hedwigia **37** : 293. 1898. (Type from Windhoek, South West Africa, on *Stenotaphrum glabrum* = *Stenotaphrum secundatum* (Walt) Kuntze.) Not *U. Stenotaphri* McAlpine, 1895.

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[1] M.H. = Mycological Herbarium, Union Dept. Agric.

[2] Wakefield and Moore in Trans. Brit. Myc. Soc. **20** : 97, 1936, call attention to the fact that the authority for this smut species should be (Pers.) Lagerh. and not (Pers.) Kell. Swingle.

Ustilago americana Speg. Anal. Mus. Nac. Buenos Aires **6** : 201. 1899.
Ustilago Henningsii Sacc. and Sydow, Sacc. Syll. Fung. **16** : 368. 1902.

Sori in the spikelets, usually infecting every ovary in a spikelet, at first more or less hidden by the surrounding leaves, at first covered by a thin, delicate olive-brown membrane which ruptures revealing an olive-brown spore mass which soon disperses leaving a naked rachis ; spores oblong-ovate, chiefly globose-subglobose, somewhat irregular, light reddish brown (almost hyaline), 5.5–8 μ diam., smooth.

Type host and locality : On *Stenotaphrum americanum* Schrank., Mandeville, Jamaica

On Paniceae : *Stenotaphrum secundatum* (Walt.) Kuntze, South-West Africa. (M.H 6879.)

Distribution : West Indies, South America, South Africa.

Ustilago Scitaminea H. Sydow,[3] Ann. Myc. **22** : 281. 1924.

Sori transforming the floral stem into a long, curved, leafless, stem-like growth covered by a thin membrane of host tissue, the lower part of the sori concealed by the sheath ; spores globose-subglobose, reddish brown, 5–12 μ diam., smooth ; groups of hyaline thin walled cells scattered through the sori.

Type locality and host : On *Saccharum officinarum* Linn., India, Java, Philippines.

On Andropogoneae : *Erianthus saccharoides* Michx., Natal ; *Imperata arundinacea Cyrilli*, Natal ; *Saccharum officinarum* Linn., Natal. (M.H. 11111.)

Ustilago puellaris Sydow, Ann. Myc. 33 : 231. 1935.

Sori entirely destroying the inflorescence, concealed by the glumes, cylindrical, usually 1 mm. long, occasionally 1–4 mm. long, covered by dark brown membrane which ruptures, disclosing a dark brown powdery spore mass ; spores globose-subglobose, rarely ellipsoidal, regular, olivaceous brown with a narrow reddish brown epispore, 7–9 μ diam., smooth but sometimes indistinctly verruculate under the oil immersion.

Type host and locality : On *Hyparrhenia hirta* Stapf, Research Station, Nelspruit, Transvaal.

On Andropogoneae : *Hyparrhenia hirta* Stapf, Transvaal. (M.H. 26646.)

Distribution : Reported only from type locality.

Ustilago Crameri Korn. Jahrb. Nassau. Ver. Naturk. 27–28 : 11. 1875.

Sori in the ovaries, completely destroying them, ovoid, covered with a delicate membrane which when ruptured reveals a brownish, granular spore mass ; spores globose-subglobose, reddish-brown, 7–10 μ diam., smooth even under oil immersion.

Type host and locality : On *Setaria italica* (Linn.) Beauv., Zurich, Switzerland.

On Paniceae : *Setaria italica* (Linn.) Beauv., Transvaal, Zululand*, Orange Free State. (M.H. 2204, 9817, 11716.)

Ustilago Cynodontis P. Henn.[4] Bot. Jahrb. (Engler) **14** : 369. 1891.

Sori destroying the inflorescence converting it into a mass of spores along the rachis, at first covered with a whitish-black membrane which breaks away revealing a black spore mass 2–4 cm. long, sometimes slightly longer ; spores globose-subglobose, regular, reddish-brown, 7–10 μ diam., smooth or almost smooth but granular.

Type host and locality : On *Cynodon Dactylon* Pers., Abyssinia, Africa.

[3] Sydow in 1924 (l.c.) pointed out that the smut on cultivated sugarcane was not *Ustilago Sacchari* Rab. and therefore proposed the name *Ustilago scitaminea* Syd. for the smut that attacks sugarcane.

[4] Verwoerd in Ann. Univ. Stellenbosch, A. **4** : 19. 1926, confuses *Ustilago Dregeana* Tul. and *U. Cynodontis* P. Henn. These are two very distinct species. *U. Dregeana* Tul. has papillate spores, 4–5 μ diam. (See Appendix A.), wihle *U. Cynodontis* P. Henn. has smooth spores, 7–10 μ diam.

On Hordeae: *Cynodon Dactylon* Pers., Orange Free State (M.H. 9752), Transvaal (M.H. 947, 112, 5636, 11005, 11014), Cape Province (M.H. 12953); *Cynodon incompletus* Nees, Transvaal (M.H. 1957, 8843), Orange Free State (M.H. 904), Cape Province (M.H. 25442).

Distribution: North America, Europe, Asia, Africa.

Ustilago Vaillanti Tul. Ann. Sci. Nat. III. **7**: 90. 1847.

Ustilago scillae Ciferri, Ann. Myc. **29**: 24. 1931.

Sori in pistils and anthers, perianth of diseased flowers persistent, somewhat enlarged and filled with spores, spores globose-ellipsoidal, sometimes angled, light reddish-brown, 7–11 μ diam., smooth but contents somewhat granular.

Type host and locality: On *Muscari comosum* (Linn.) Mill., Europe.

On Liliaceae: *Albuca altissima* Dryand., Cape Province (M.H. 15450); *Eucomis punctata* L'Herit., Cape Province (M.H. 2001); *Scilla Kraussii* Baker,* Inanda, Natal (M.H. 9525); *Scilla* sp., Cape Province,* Natal (M.H. 12956).

Distribution: United States, Europe, Africa.

Ustilago Dactyloctaenii P. Henn. Die Pflanzenwelt Ost-Afrika, Nachbar. C: 48. 1895.

Sori entirely destroying the inflorescence, at first covered by a membrane which flakes away revealing a dark purplish spore mass, at first slightly agglutinated but later powdery; spores globose-subglobose, regular, light olivaceous-brown, 7–14 μ diam., granular, smooth, epispore 1–2 μ.

Type host and locality: On *Dactyloctenium aegyptium* (L.) Richt. (=*Dactyloctenium aegyptiacum* Willd.), Zanzibar, Africa.

a On Chlorideae: *Dactyloctenium aegyptium* (L.) Richt., Cape Province (M.H. 9114); *Dactyloctenium geminatum* Hack., Portuguese East Africa (M.H. 14175).

** Spores not smooth.

Ustilago Avenae (Pers.) Jens. Charb. Cereales 4. 1889.

Reticularia segetum Bull. Champ. *pl.* 472, *fig. II.* 90. 1791. p.p.

Uredo carbo Avenae DC., Fl. Fr. 6. 76. 1815

Ustilago segetum Link, Ditm. in Sturms Deutsch. Fl. III. **1**: 67. 1817. p.p.

Caeoma segetum Link, Willd. Sp. Pl. **62**: 1. 1825.

Erysibe vera Avenae Wallr. Fl. Crypt. Germ. 2: 217. 1833.

Uredo carbo-avenae Phillipar, Mem. Soc. Roy. Agr. Arts Seine-et-Oise **37**: 194. 1837.

Ustilago carbo-vulgaris avenae Tul. Ann. Sci. Nat. Bot. III. **7**: 80. 1847.

Ustilago segetum Avenae Jens. Om Korns. Brand 61. 1888.

Ustilago Avenae f. *foliicola* Almeida, Revista Agron. (Lisbon), **1**: 20. 1903.

Sori in the spikelets, 5–12 mm. long, usually destroying the inflorescence rather completely and most of the spores finally being blown away, rarely on the leaves or culms; spores spherical to subspherical or sometimes more elongate, olivaceous-brown, sometimes lighter colored on one side of the spore, 5–7 μ diam., minutely echinulate.

Type host and locality: On *Avena sativa* Linn., Europe.

On Avenae: *Avena sativa* Linn., Cape Province, Transvaal. (M.H. 8923.)

Distribution: Co-extensive with cultivated oats.

Ustilago Holubii Sydow, Ann. Myc. **33**: 230. 1935.

Sori entirely destroying the panicle and sometimes extending into the end of the culms usually 2–4 cm. long, covered by a dark colored membrane which flakes away revealing a brown spore mass; spores globose-subglobose, olivaceous-brown, 5–7 μ diam., apparently smooth but minutely verruculate under oil immersion.

Type host and locality: On *Echinochloa Holubii* Stapf, Pretoria, Transvaal, Union of South Africa.

On Panicaceae: *Echinochloa* (*Panicum*) *Holubii* Stapf, Cape Province,* British Bechuanaland, Transvaal.* (M.H. 24942 (type), 17042.)

Distribution: South Africa.

Ustilago Tritici (Pers.) Rostrup, Overs. Danske. Vid. Selsk. Forh. **1890**: 15. Mr. 1890.

Lycoperdon Tritici Bjerk. Kgl. Schmedisch Akad. Wiss. Abhandl. **37**: 326. 1775.
Uredo segetum Tritici Pers. Disp. Meth. Fung. 57. 1797.
Uredo carbo Tritici DC. Fl. Fr. **6**: 76. 1815.
Ustilago setum Ditm. Sturm's Deuts. Flore III. **1**: 67. 1817.
Caeoma segetum Link, Willd. Sp. Pl. **62**: 1. 1825.
Erysibe vera Tritici Wallroth, Fl. Crypt. Germ. **2**: 217. 1833.
Uredo Carbo-Tritici Philippar, Soc. Roy. Agr. Arts Seine-et-Oise **37**: 197. 1837.
Ustilago Carbo vulgaris Triticea Tul. Ann. Sci. Nat. Bot. III. **7**: 80. 1847.
Ustilago segetum var. *Tritici* Jens. Om Korns. Brand 61. 1888.
Ustilago Hordei Bref. Nach. Klub. Landw. Berl. No. 1593. 1888.
Ustilago Tritici Jens. Kelleran and Swingle in Ann. Rep. Kansas Exp. Sta. **2**: 262. 1890.
Ustilago Tritici foliicola P. Henn. Zeitschr. Pflanzen. **4**: 139. 1894.
Ustilagidium Tritici Herzb. Zopff. Beitr. Phys. Morph. Neiderer Org. **5**: 7. 1895.
Ustilago Vavilovi Jacz. (Ann. State Inst. Exp. Agr. III. 2–4: 106–109. 1925. Transl. Title).

Sori in the spikelets, forming a dusty olive-brown spore mass, eventually destroying all of the inflorescence and the spores are blown away leaving only the naked rachis; spores spherical or subspherical, sometimes more elongated and irregular, light olive-brown, usually lighter colored on one side of the spore, 5–9 μ diam., minutely but distinctly echinulate. While the entire wheat spike is usually destroyed and only the naked rachis left, yet partial destruction of the spike is not uncommon. Under rare conditions the sorus develops on the sheaths and leaves.

Type host and locality: On *Triticum vulgare* Vill., Europe.

On Hordeae: *Triticum vulgare*, Cape Colony*, Orange Free State, Transvaal. (M.H. 1068, 9821.)

Distribution: Co-extensive with the cultivation of wheat.

Ustilago Fingerhuthiae Sydow, Ann. Myc. **33**: 230. 1935.

Sori in the ovaries, 2–5 mm. long, scattered throughout the spike, covered with a yellowish membrane that dehisces revealing a brownish, granular, spore mass; spores globose-subglobose, regular, olivaceous-brown 5–10 μ diam., densely but minutely verruculose-echinulate.

Type host and locality: On *Fingerhuthia africana* Lehm., Pretoria, Transvaal, Union of South Africa.

On Festuceae: *Fingerhuthia africana* Lehm., Transvaal. (M.H. 1085, 7405, 8909.)

Distribution: Not reported except from type locality.

Ustilago trichophora (Link) Kunze, Flora **1**: 369. 1830.

Caeoma trichophora Link, Willd. Sp. Pl. **62**: 3. 1825.
Uredo trichophora Körn. Hedwigia **16**: 36. 1877.

Sori as small nodules in the individual ovaries, scattered in the panicle, singly or in groups, 2–5 mm. long, covered by a yellowish tough, hispid membrane, spore mass at first hard, agglutinated but later powdery; spores globose-subglobose, light reddish-brown (some immature spores almost hyaline), 7–8 μ diam., abundantly echinulate under oil immersion.

Type host and locality : On *Echinochloa colona* (=*Panicum colonum* Linn.), Egypt.
On Paniceae : *Echinochloa Crus-galli* Beauv. (=*Panicum Crus-galli* Linn.), Cape Province. (M.H. 9424.)
Distribution : Africa.

Ustilago Trachypogonis Zundel n. sp.

Sori in the ovaries, protected by the outer glumes, about 1 cm. long, spore mass granular, dark brown ; spores globose-subglobose, occasionally ellipsoidal, brown with a distinctly reddish-brown epispore, 7–9 μ diam., echinulate.

Hab. in the ovaries of *Trachypogon plumosus* Nees., Kaalfontein, Transvaal, Union of South Africa, Coll. A.O.D. Mogg, Feb. 22, 1918. (M.H. 11709.)

Latin description :—

Soris in ovariis, glumis externis tectis, ca. 1 cm. longis, globis sporarum grandularibus, atro-brunneis ; sporis globosis v. sub-globosis, interdum ellipsoideis, brunneis, 7–9 μ diam., echinulatis ; episporio conspicue rubro-brunneo.

Hab. in ovariis *Trachypogonis plumosi* Nees., Kaalfontein, Transvaal, Unione Africae Australis, Coll. A. O. D. Mogg, Feb. 22, 1918. (M.H. 11709.)

Ustilago Schlechteri P. Henn. Hedwigia **34** : 325. 1895.

Sori in the panicles, 8 or more cm. long, deforming and destroying the inflorescence, at first covered with a membrane which ruptures revealing a dark spore mass ; spores globose-subglobose or sometimes ellipsoidal, deep olivaceous-brown with a deeper almost reddish-brown epispore, 7–10 μ diam., or sometimes slightly larger, minutely echinulate-verruculose under oil immersion.

Type host and locality : On *Sporobolus* sp., Tweedie, Natal. (M.H. 11644.)
On Agrostideae : *Sporobolus* sp., Natal. (M.H. 11644.)
Distribution : Union of South Africa.

Ustilago Crus-galli Tracy and Earle, Bull. Torrey Club **22** : 175. 1895.

Sori surrounding the stem at nodes or place of inflorescence, attacking both stem and leaves, nodular, elongated, swollen, several cm. long, surrounded by a tough hispid membrane, spore mass brown, powdery ; spores ovoid to spherical, occasionally more elongate, olivaceous-brown, 7–10 μ diam., bluntly echinulate.

Type host and locality : On *Panicum crus-galli* Linn., Salt Lake City, Utah, United States.
On Paniceae : *Echinochloa Holubii* Stapf, Transvaal. (M.H. 2247.)
Distribution : United States, Europe, Asia, Africa, Australia.

Ustilago Zeae (Beckm.) Unger. Einfl. Bodens 211. 1836.
Lycoperdon zeae Beckm. Hannov. Mag. **6** : 1330. 1768.
Uredo segetum Mays Zeae DC. Fl. Fr. **2** : 596. 1805.
Uredo Zeae Mays DC., Lamarck Enc. Meth. Bot. **8** : 229. 1808.
18 *Uredo maydis* DC. Fl. Fr. **6** : 77. 1815.
Uredo Zeae Schw. Fung. Car. No. 71. 1815.
Caeoma Zeae Link, Willd. Sp. Pl. **62** : 2. 1825.
Erysibe Maydis Wallroth, Fl. Crypt. Germ. **2** : 215–16. 1833.
Ustilago Maydis Corda, Corda Icon. Fung. **5** : 3. 1842.
Ustilago Schweinitzii Tul. Ann. Sci. Nat. Bot. III. **7** : 86. 1847.
Ustilago Zeae-Mays Wint. Rab. Krypt.-Fl. **11** - 97. 1881.
Ustilago Euchlaenae Arcang. Erb. Critt. Ital. **11** : 1132. 1882.
Ustilago Mays zeae Magnus, Deuts. Bot. Monatschr. **13** : 50. 1895.

Sori forming on any part of the host above ground as irregular pustules measuring a few mm. to large boils several dm. in diam., at first covered with a membrane composed of host tissue intermixed with fungous threads which later breaks revealing an olive-brown spore mass; spores globose to subglobose or sometimes ellipsoidal, regular, reddish-brown, 7–10 μ diam., bluntly echinulate.

Type host and locality: On *Zea Mays* Linn., Europe.

On Andropogoneae: *Zea Mays* Linn., Cape Colony (M.H. 1178, 14699, 11632), Natal,* Transvaal.*

Distribution: North America, Europe, Asia, Africa, Philippine Islands.

Ustilago bromivora (Tul.) Fisch. de Waldh. Bull. Soc. Nat. Moscow **40**[1]: 252. 1867.
Ustilago carbo vulgaris bromivora Tul. Ann. Sci. Nat. Bot. III. **7**: 81. 1847.
Cintractia patigonica Cooke and Massee, Grevillea **18**: 34. 1899.
Ustilago Brachypodii Maire, Bull. Soc. Hist. Nat. Afr. Nord **9**: 46. 1918.
Ustilago Brachypodii-distachyi Maire, Bull. Soc. Hist. Nat. Afr. Nord **10**: 46. 1919.
Ustilago bromivora Tul. forma *Brachypodii* Hariot, Bull. Soc. Hist. Nat. Afr. Nord **12**: 192–1921.
Ustilago bromi-arvensis Liro, Ann. Acad. Sci. Fenn. A. **17**: 93. 1924.
Ustilago Bromi-mollis Liro, Ann. Acad. Sci. Fenn. A. **17**: 94. 1924.

Sori in the spikelets, usually confined within the glumes, sometimes infecting base of glumes, covered with a delicate white membrane, usually bullate, agglutinated then powdery; spores globose-subglobose, occasionally broadly ellipsoidal, dark reddish-brown to olivaceous-brown, chiefly 7–11 μ diam., abundantly verruculose.

Type host and locality: On *Bromus secalinus* Linn., Europe.

On Festuceae: *Bromus unioloides* H.B.K., Cape Colony (M.H. 544, 1248, 11004, 12832), Orange Free State (M.H. 2091), Transvaal (M.H. 280, 284, 285, 195, 429, 6933).

Distribution: North America, Europe, Asia, Africa, Australia, New Zealand.

Ustilago Andropogonis-finitimi Maub. Bull. Soc. Myc. (France) **22**: 74–75. 1906.

Sori in the ovaries, long linear, 5–7 mm. long, covered with a membrane of host tissue; spore mass brown, agglutinated, surrounding a well developed columella; spores globose-subglobose, semi-opaque, dark reddish-brown, 9–12 μ diam., abundantly echinulate unde-oil immersion.

Type host and locality: *On Andropogon finitimus* Hochst. Portuguese East Africa

On Andropogoneae: *Andropogon finitimus* Hochst., Portuguese East Africa.

Distribution: Reported only from type locality.

Ustilago Rabenhorstiana Kuhn, Hedwigia **15**: 4. 1876.
Caeoma Syntherismae Schw. Trans. Am. Phil. Soc. II. **4**: 290. 1834.
Ustilago Setariae Rabenh. Univ. itin. Krypt. No. 1866. Year *
Ustilago destruens var. *Digitariae* Sacc. Nuo. Giorn. Bot. Ital. **8**: 167. 1876.
Ustilago Cesati Fisch. de Waldh. Apercu **25**: 1877. p.p.
Ustilago Syntherismae Auct. p.p. Cke. Grevillea **6**: 138. 1878.

Sori usually destroying the entire inflorescence, linear–oblong, 3–5 cm. long, at first concealed by the enveloping glumes but finally becoming visible as a black-brown dusty spore mass surrounding the elongate remnants of the inflorescence; spores globose–subglobose, occasionally somewhat angled, olivaceous-brown, 10–13 μ diam., verruculose.

Type host and locality: On *Panicum sanguinale* Linn., Europe.

On Paniceae: *Digitaria ternata* Stapf, Natal (M.H. 11703); *Digitaria* sp., Rhodesia (M.H. 13999), Transvaal (M.H. 11704).

[1] This species is similar to, if not identical with *Ustilago sphaerogena* Burrill, found in North America.

Ustilago Peglerae Sydow and Bubak, Ann. Myc. **12** : 264. 1914.

Sori destroying the anthers, olivaceous-black ; spores ellipsoidal to oblong, seldom globose to subglobose, frequently irregular, olivaceous-brown, 10–14 μ long, verruculose.

Type host and locality : On *Ornithogalum lacteum* Jacq., Cape Province, Union of South Africa.

On Liliaceae : *Ornithogalum lacteum* Jacq., Cape Colony (M.H. 7101).

Distribution : Cape Province.

Ustilago Evansii P. Henn. Bot. Jahrb. (Engler) **41** : 270. 1908.

Sori destroying all ovaries on the spike, 2–3 mm. long, covered with an olivaceous membrane ; spore mass granular, olive-brown ; spores globose–subglobose, regular, olivaceous-brown, light colored almost hyaline, spores abundant throughout the sorus, various sizes, 14–21 μ diam., abundantly and coarsely echinulate, bifurcate conidiophores abundant.

Type host and locality : On *Setaria sphacelata* Stapf and Hubb. (=*Setaria aurea* A. Br.), Zoutpansberg, Transvaal, Union of South Africa.

On Paniceae : *Setaria sphacelata* Stapf. and Hubb., Natal (M.H. 7757), Transvaal (M.H. 7797), Rhodesia (M.H. 14003), Zululand (M.H. 15441, 17044, 17045) ; *Setaria nigrirostris* Dur. and Schinz., Transvaal, Rhodesia ; *Setaria* sp., Southern Rhodesia.

Farysia Raciborski, Sci. Cl. Sci. Math. Nat. 1. **1909** : 354. 1909.
Elateromyces Bubak, Houby Céská Dil. II. **1912** : 32. 1912.

Sori in various parts of the host, at maturity forming dusty, usually dark spore masses, intermixed with parallel, elater-like strands of host tissue and sterile hyphae ; spores single, produced in chains as in *Ustilago* but intermixed with sterile hyphae and strands of host tissue which function as elaters.

Farysia olivacea (DC.) H. and P. Sydow, Ann. Myc. **17** : 41. 1919.
Uredo olivacea DC. Fl. Fr. **6** : 78. 1815.
Caeoma olivaceum Schlecht. Fl. Berol. **2** : 130. 1824.
Erysibe olivacea Wallr. Fl. Crypt. Germ. **2** : 215. 1833.
Ustilago olivacea Tul. Ann. Sci. Nat. III. **7** : 88. 1847.
Ustilago catenata Ludw. Zeits. Pflanz. **3** : 139. 1893.
Cintractia caricicola P. Henn. Hedwigia **34** : 325. 1895.
Ustilago caricicola Tracy and Earle, Bull. Torrey Club **26** : 493. 1899.
Ustilago subolivacea P. Henn. Ann. R. Istit. Bot. Roma **6** : 84. 1897.
Elateromyces olivacea Bubak, Houby Cesky Dil. II. **1912** : 32. 1912.
Farysia americana Ciferri, Ann. Myc. **29** : 73. 1931.

Sori in occasional ovaries, often at first partly concealed by the perigynium, ovate, 2–6 mm. in diam., at first with agglutinated spores which later become powdery, with conspicuous elaterlike threads intermixed with the spores ; spores olivaceous-brown, irregular, varying from globose to oblong or linear but sometimes more regular and then chiefly 7–9 μ diam., the most elongate about 12 μ long and about 4 μ wide, abundantly but minutely verruculate.

Type host and locality : On *Carex riparia* Curtis, France.

On Cyperaceae : *Carex ethiopica* Schkuhr., Cape Province ; *Carex phacota* Spreng., Cape Province. (M.H. 8812.)

Distribution : North America, South America, West Indies, Europe, Asia, South Africa, New Zealand, Tasmania, Australia.

Sphacelotheca De Bary, Verg. Morph. Biol. Pilée 187. 1884.
Sporisorium Ehrenb. Link Willd. Sp. Pl. **62** : 86. 1825.
Endothlaspis Sorokin, Rev. Myc. **12** : 4. 1890.

Sori usually in the inflorescence, often limited to the ovaries, provided with a definite (more or less) temporary false membrane covering a dusty spore mass and a central columella of plant tissue; false membrane composed largely or entirely of definite sterile fungous cells which are hyaline or slightly tinted; oblong to spherical, and usually more or less firmly bound together; spores simple, usually reddish-brown, developed in a somewhat centripital manner as in *Cintractia*, small to medium in size; germination as in *Ustilago*.

Type: *Uredo Hydropiperis* Schum., on *Polygonum Hydropiper* Linn., Europe.

Sphacelotheca Anthephorae (Syd.) Zundel n.n.

Ustilago Anthephorae Syd. Ann. Myc. **12**: 197. 1914.

Sori completely destroying the inflorescence hidden by the glumes; about 1 cm. long, surrounded by a delicate membrane which dehisces apically revealing an agglutinated brown spore mass surrounding a well formed columella and breaking up into sterile cells; sterile cells subglobose–irregular, hyaline, singly or in chains, about 7 μ diam.; spores globose–subglobose, reddish-brown, 3.5–4.5 μ diam., smooth.

Type host and locality: On *Anthephora pubescens* Nees, Grootfontein, South West Africa.

On Zoysieae: *Anthephora pubescens* Nees, South West Africa,* Transvaal (M.H. 2249, 5151), Orange Free State (M.H. 26644).

Distribution: Southern Africa.

* Spores smooth.

Sphacelotheca Sorghi (Link) G. P. Clinton, Jour. Myc. **8**: 140. 1902.

Sporisorium Sorghi Link, Willd. Sp. Pl. **62**: 86. 1825.

Tilletia Sorghi-vulgaris Tul. Ann. Sci. Nat. III. **7**: 116. 1847.

Ustilago sorghi Pass. Thum. Hedwigia **12**: 114. 1873.

Cintractia Sorghi-vulgaris G. P. Clinton, Bull. Ill. Agr. Exp. Sta. **47**: 404. 1897.

Sori destroying the ovaries which are elongated about twice the normal length of the seed, covered with an evident false membrane which ruptures revealing a brown spore mass surrounding a short, thick, well developed columella; false emmbrane usually breaking up into chains of small hyaline sterile cells, subglobose-ellipsoidal, 3–10 μ diam.; spores globose–subglobose, reddish-brown, 3–8 μ diam., mostly about 5 μ diam., smooth.

Type host and locality: On *Sorghum vulgare* Pers., Egypt.

On Andropogoneae: *Sorghum vulgare* Pers. v. *caffrorum* (Thun.) Hubb. et Rehder (=S. *caffrorum* Beauv. and =*Andropogon sorghum* Brot. var.), Cape Province, Natal (M.H. 17271), Transvaal (M.H. 315, 316, 5635, 2088, 7786).

Distribution: Co-extensive with cultivated sorghums.

Sphacelotheca Moggii Zundel, Mycologia **22**: 130. 1930.

Sori in the inflorescence, long linear, 5–10 mm. long, at first usually hidden by the outer leaf sheath, later protruding, covered with a false tissue which flakes away revealing a dark brown, agglutinated spore mass surrounding a well developed, often forked, columella; sterile tissue very fragile and "tissue like," somewhat effervescent, adhering more or less to the sori and breaking up into groups or balls of sterile cells which are tinted brown, vacuolated and granular, 7–12 μ diam., sterile-cell balls containing 4 or more cells, globose–subglobose, 15–22 μ diam.; balls of sterile cells are scattered throughout the sori; spores globose–subglobose, regular, tinted olivaceous-brown to almost hyaline, vacuolated, 4–6 μ diam., under oil immersion, smooth.

Type host and locality: On *Cymbopogon plurinodis* Stapf, Armoedsvlakte, British Bechuanaland.

On Andropogoneae: *Cymbopogon plurinodis* Stapf, British Bechuanaland. (M.H. 19859.)

Distribution: Not reported except from type locality.

Sphacelotheca cruenta (Kuhn) Potter, Phytopath. **2** : 98. 1912.

Ustilago cruenta Kühn, Hamburg Gart. Blumenztig. **28** : 177–178. 1872.

Ustilago Tulasnei Kühn, Rab. Fungi Eur. No. 1997. 1875.

Sphacelotheca cruenta Bubak, Archiv Pirod. Vyck. Cech. **15** : 27. 1912. Archiv. Naturw. Landes. Bohmen **15** : 26. 1916.

Sori destroying the ovaries, which are scarcely larger than normal, covered by an evident membrane which flakes away into globose sterile cells revealing a brown granular spore mass surrounding a long, curved, well developed columella ; groups of large globose sterile cells scattered throughout the sori ; sterile cells hyaline, globose–subglobose, singly or in groups, 9–14 μ diam. ; spores globose–subglobose, light reddish-brown, 5–8 μ diam., smooth.

Type host and locality : *Sorghum vulgare* Pers., Halle, Germany.

On Andropogoneae : *Sorghum halepense* Pers., Tanganyika Territory ; *Sorghum vulgare* Pers., Tanganyika Territory ; *Sorghum* sp., Tanganyika Territory.

Distribution : North America, Europe, West Indies, Africa.

Sphacelotheca Vryburgii Zundel, Mycologia **23** : 298. 1931.

Sori in the inflorescence, long linear, 5–10 mm. long, at first hidden by the glumes but later protruding, covered by a reddish-brown, delicate false membrane which flakes away revealing an agglutinated black spore mass surrounding a well developed much branched columella ; sterile cells hyaline, globose, usually in groups, 9–15 μ diam. ; spores globose–subglobose, occasionally angled, very light reddish-brown, 4–8 μ diam., smooth, contents finely granular with a hyaline to light coloured wall under oil immersion.

Type host and locality : On *Themeda triandra* Forsk. (=*Themeda Forskalii* Hack.), Vryburg, British Bechuanaland.

On *Themeda triandra* Forsk., British Bechuanaland (M.H. 9733.)

Distribution : Reported only from type locality.

Sphacelotheca concentrica Zundel, Mycologia **22** : 138. 1930.

Sori in the inflorescence, broadly elongate, 1 cm. or less in length, at first concealed by the glumes, covered by an evident light coloured false membrane which flakes away revealing a partially agglutinated dark spore mass surrounding a well formed columella ; sterile tissue breaking up into hyaline cells, globose, somewhat variable in size, ranging from 10–21 μ diam. ; spores globose–subglobose, under oil immersion the spore is divided into four concentric parts, an outer dark brown area, then a light reddish-brown area and an inner vacuolated, light coloured area, surrounded by a second dark brown area, 6–8 μ diam. but sometimes 4–8 μ diam., smooth.

Type host and locality : On *Cymbopogon plurinodis* Stapf, Pretoria, Union of South Africa.

On Andropogoneae : *Cymbopogon plurinodis* Stapf, Transvaal (M.H. 10708).

Distribution : Not reported except from type locality.

Sphacelotheca densa (McAlp.) Ciferri, Ann. Myc. **26** : 32. 1928.

Cintractia densa McAlp., Smuts of Australia 168. 1910.

Sori destroying the inflorescence and forming a long rachis, covered with a greyish membrane which flakes away exposing a dark spore mass ; spores globose–subglobose, light olivaceous-brown, 6–7 μ diam., smooth.

Type locality and host : On *Rottboellia compressa* Linn., Burnley near Melbourne, Victoria, Australia.

On Andropogoneae : *Rottboellia compressa* Linn., Natal (M.H. 12957).

Distribution : Australia, South Africa.

Sphacelotheca Doidgeae Zundel, Mycologia **22** : 131. 1930.

Sori in the inflorescence usually involving the entire spikelet along the rachis, long linear, frequently irregularly branched or compound, 3–8 mm. long, covered with an evident,

thick, brown, false membrane, which dehisces from the apex disclosing a brown, agglutinated mass of spores surrounding a well developed irregular columella ; sterile tissue breaking up into groups or chains of hyaline sterile cells, 6-10 μ diam. ; groups of large globose sterile cells through the sori ; spores globose subglobose, thick walled, olivaceous brown, 6–10 μ diam., under oil immersion, smooth and finely granular.

Type host and locality : On *Bothriochloa glabra* A. Camus, Edendale, Natal, Union of South Africa (M.H. 1997).

On Andropogoneae : *Bothriochloa* sp. Transvaal (M.H. 15058) ; *Andropogon intermedius* R. Br., Natal (M.H. 8939) ; *Bothriochloa glabra* A. Camus, Natal (M.H. 1997).

Distribution : Southern Africa.

Sphacelotheca tenuis (H. and P. Sydow) Zundel, Mycologia **22** : 137. 1930.

Ustilago tenuis H. and P. Sydow, Ann. Myc. **4** : 425. 1906.

Sori destroying the inflorescence, ½–1 cm. long, covered with a more or less permanent false membrane which flakes away revealing a semi-powdery spore mass surrounding a well developed columella ; cells of sterile membrane are inclined to fuse and largely lose their cellular structure, appearing as a more or less amorphous mass, however, some globose cells retain their identity ; spores globose–subglobose, somewhat irregular and angular, thick walled, olivaceous-brown, 6–10 μ diam., smooth and finely granular under oil immersion.

Type host and locality : On *Bothriochloa pertusa* A. Camus (=*Andropogon pertusus* Willd.), Hunsur, Mysore, India.

On Andropogoneae : *Hyparrhenia* sp., Natal (M.H. 11862).

Distribution : India, South Africa.

Sphacelotheca columellifera (Tul.) Ciferri, Ann. Myc. **26** : 32. 1928.

Ustilago carbo var. *columellifera* Tul. Ann. Sci. Nat. Bot. III. **7** : 81. 1847.

Cintractia columellifera (Tul.) McAlpine, Smuts of Austr., 166. 1910.

Sori destroying the inflorescence, long linear, 5–7 cm. long, at first concealed by the sheath but later protruding, covered by an evident yellowish-white, false membrane which flakes away revealing a dark brown agglutinated spore mass surrounding a well developed, hollow columella ; false membrane disintegrating into groups or chains of globose, hyaline sterile cells, 7–12 μ diam. ; spores generally globose, regular but occasionally subglobose, light reddish-brown, usually 7 μ diam., but occasionally 9 μ, under oil immersion, smooth with vacuolated contents.

Type host and locality : *Andropogon australis* Spreng., Queensland, Australia.

On Andropogoneae : *Heteropogon contortus* R. and S. (=*Heteropogon hirtus* Pers.), Tanganyika Territory.

Distribution : Australia, Africa.

Sphacelotheca Ruprechtii Sydow, Ann. Myc. **33** : 232. 1935.

Sori entirely destroying the inflorescence, cylindrical, 4–8 mm. long, at first concealed by the glumes but later protruding, covered by a leathery, olivaceous false membrane which ruptures disclosing a dark agglutinated spore mass surrounding a well developed simple or bifurcate columella ; sterile cells globose–subglobose, hyaline, in pairs or in groups, rarely in chains, 10–14 μ diam., spores globose–subglobose, regular, olivaceous-brown 7–10 μ diam., smooth but granular under the oil immersion lens.

Type host and locality : On *Hyparrhenia Ruprechtii* Fourn. (*Andropogon Ruprechtii* Hack.), Marikana, Rustenburg, Transvaal, Union of South Africa.

On Andropogoneae : *Hyparrhenia Ruprechtii* Fourn., Transvaal (M.H. 27377).

Distribution : Southern Africa.

Sphacelotheca Evansii Zundel, Mycologia **22** : 133. 1930.

Sori in the inflorescence, hidden by the glumes, inconspicuous, 5–10 mm. long, covered by an evident membrane which flakes away revealing a dark brown spore mass surrounding

a well developed columella ; false tissue rather permanent, breaking up into large groups or chains of sterile cells ; groups of sterile cells through the sorus ; sterile cells hyaline, irregular, globoid, 9–12 μ diam. ; spores globose-subglobose, regular, olivaceous-brown, 8–10 μ diam., under oil immersion, smooth and vacuolated.

Type host and locality : On *Hyparrhenia Ruprechtii* Fourn., Olifants River, Transvaal, Union of South Africa.

On Andropogoneae : *Hyparrhenia Ruprechtii* Fourn., Transvaal (M.H. 14174).

Distribution : Transvaal.

Sphacelotheca Andropogonis (Opiz) Bubak, Naturw. Landes. Böhmen, **15** : 25. 1916.
Ustilago Ischaemi Fuckel, Enum. Fung. Nass. 22 : 1861.
Ustilago cylindrica Peck, Bot. Gaz. **7** : 55. 1882.
Cintractia Ischaemi Syd. Oesterr. Bot. Zeitsch. **51** : 12. 1901.
Sphacelotheca Ischaemi Clint. Jour. Myc. **8** : 140. 1902.

Sori usually involving entire inflorescence, hidden by the sheath, long linear, 10–40 mm. long by 1–4 mm. wide, covered by a false membrane which flakes away disclosing a brown spore mass surrounding a well developed columella ; false membrane rather permanent, breaking up into large masses of tissue rather than individual sterile cells, sterile cells through the sori ; sterile cells globose–subglobose, flattened when in contact with each other, hyaline or when en masse, tinted brown, 7–16 μ diam. ; spores globose –subglobose medium reddish-brown, minutely granular, 8–10 μ diam. smooth.

Type host and locality : On *Andropogon Ischaemum* Linn., Prag, Czechoslovakia.

On Andropogoneae : *Bothriochloa glabra* A. Camus. Natal (M.H. 1080, 7759), Transvaal (M.H. 1073, 1921) ; *Cymbopogon Schoenanthus* Spreng., Transvaal (M.H. 1921) ; *Hyparrhenia Ruprechtii* Fourn., Transvaal (M.H. 1156, 10096).

Distribution : North America, Europe, Asia, Africa, Philippine Islands.

Sphacelotheca Dinteri (H. and P. Sydow) Zundel, Mycologia **22** : 140. 1930.
Ustilago Dinteri H. and P. Sydow, Ann. Myc. **13** : 37. 1915.

Sori destroying the entire enflorescence, almost entirely hidden by the terminal sheath, long linear, 2–4 cm. long, covered by an evident brown false membrane which flakes away revealing a semi-powdery, brown, spore mass surrounding a well formed columella ; sterile cells globose–subglobose or sometimes ellipsoidal, individually or in groups, tinted brown, 7–12 μ diam. ; spores globose–subglobose or occasionally ellipsoidal, frequently angular, thick walled, finely granular, olivaceous brown, 9–12 μ diam., smooth.

Type host and locality : On *Dicanthium papillosum* Stapf (=*Andropogon papillosus* Hochst.), Pijikuara-Okaharni, South West Africa.

On Andropogoneae : *Dicanthium papillosum* Stapf, South West Africa.

Distribution : South West Africa.

Sphacelotheca natalensis Zundel, Mycologia **22** : 139. 1930.

Sori in the inflorescence, long linear, 3–6 mm. long, covered by an evident brown false membrane which flakes away revealing an agglutinated spore mass surrounding a well developed, simple, columella ; sterile cells globose, usually hyaline, mostly in groups or short chains, reddish-brown en masse, variable in size, 12–15 μ diam. ; spores globose–subglobose, thin walled, light reddish-brown, 10–12 μ diam., smooth even under oil immersion.

Type host and locality : On *Cymbopogon excavatus* Stapf, Mooi River, Natal, Union of South Africa.

On Andropogoneae : *Cymbopogon excavatus* Stapf, Natal (M.H. 11705).

Distribution : Not reported except from type locality.

Sphacelotheca transvaalensis Zundel, Mycologia **22** : 139. 1930.

Sori destroying the inflorescence, broadly linear, 5–10 mm. long, covered by a thick, dark brown, false membrane which flakes away revealing a black spore mass surrounding

a large, well developed, branched, root-like, central columella and numerous surrounding smaller columellae. (Resembling a small root system of an herbaceous plant) ; sterile cells globose–subglobose, hyaline, delicate, large, single or in short chains, 11–12 μ diam. ; spores globose–subglobose, regular, reddish-brown, 10–12 μ diam., smooth but finely granular under oil immersion.

Type host and locality : On *Sorghum versicolor* Anderss., Onderstepoort, Pretoria, Transvaal, Union of South Africa.

On Andropogoneae : *Sorghum versicolor* Anderss. Transvaal (M.H. 17047).

Distribution : South Africa.

** Spores not smooth.

Sphacelotheca Milbraedii (H. and P. Sydow) Zundel, Mycologia **22** : 135. 1930.

Ustilago Milbraedii H. and P. Sydow, Wissensch. Ergebn. Deutsch Zentral. Exped. 1907–1908 : 95. 1911.

Sori in the ovaries, long linear, 3–5 cm. long, covered with an evident false membrane which flakes away disclosing a semi-powdery spore mass surrounding a well formed columella, outer false membrane rather persistent, breaking up into large groups of sterile cells, rectangular, tinted brown, groups of sterile cells through the sori, subglobose, tinted brown, 9–12 μ diam. ; spores globose–subglobose, irregular, somewhat angular, thin walled, light brown with a darker coloured centre, 3–8 μ diam., under oil immersion faintly echinulate.

Type host and locality : On *Cymbopogon Schoenanthus* Spreng. (=*Andropogon Schoenanthus* Linn.), Mpororo, Tanganyika Territory.

On Andropogoneae : *Cymbopogon Schoenanthus* Spreng., Tanganyika Territory.

Distribution : Tanganyika Territory.

Sphacelotheca Amphilophis Sydow, Ann. Myc. **33** : 232. 1935.

Sori destroying the entire inflorescence, 1–2 cm. long, at first covered by a false membrane which flakes away revealing a dark brown agglutinated spore mass surrounding a large, well developed, simple or bitrifurcate columella ; sterile cells scattered throughout the sori, usually in rather agglutinated groups but occasionally single or in groups of two or three, hyaline, globose–subglobose, regular, 7–13 μ diam. ; spores globose–subglobose, rarely ellipsoidal, regular, olivaceous–brown, 5–7 μ diam., apparently smooth but under the oil immersion lens sometimes indistinctly verruculose.

Type host and locality : On *Bothriochloa insculpta* A. Camus (=*Amphilophis insculpta* Stapf), along Crocodile River at Schagen, Barberton, Transvaal.

On Andropogoneae : *Bothriochloa insculpta* A. Camus, Transvaal (M.H. 26023).

Distribution : Reported only from type locality.

Sphacelotheca Ritchiei Zundel, Mycologia **22** : 138. 1930.

Sori in the inflorescence, long linear, 5–8 mm. long, sometimes gregarious, at first concealed by the glumes, later protruding, covered by an evident dark brown false membrane which flakes away apically, revealing a brown spore mass surrounding a well developed columella ; sterile cells hyaline, in pairs, in short chains or in groups (usually in pairs) usually larger than the spores, 9–12 μ diam., sometimes up to 15 μ, thin walled and somewhat fragile ; spores globose–subglobose, regular, reddish-brown, 6–10 μ diam., under oil immersion minutely verruculate.

Type host and locality : On *Hyparrhenia cymbaria* Stapf, Morogoro, Tanganyika Territory.

On Andropogoneae : *Hyparrhenia cymbaria* Stapf, Tanganyika Territory (M.H. 20650).

Distribution : Not reported except from type locality.

Sphacelotheca Holci H. S. Jackson, Monogr. Univ. Puerto Rico, Ser. B., No. 2 : 259. 1934.

Sori in the ovaries, concealed by and not exceeding the glumes, covered by a membrane which flakes away as sterile cells (not found in sori of old specimens) revealing a granular

spore mass surrounding a well formed columella ; sterile cells throughout the sorus, globose–ellipsoidal, singly, in pairs or groups, slightly tinged very light brown, 9–17 μ diam. ; spores globose–subglobose, olivaceous-brown with a dark reddish-brown epispore, 7–10 μ diam., finely but evident verruculose to echinulate.

Type host and locality.

On Andropogoneae : *Sorghum vulgare* Pers. v. *caffrorum* (Thun.) Hubb. et Rehder. (=*Sorghum caffrorum* Beauv.), Tanganyika Territory.

Distribution : Venezuela and Tanganyika Territory.

Sphacelotheca Zilligii Zundel, Mycologia **22** : 142. 1930.

Sori in the inflorescence, solitary, long linear, at first concealed by the sheath, 1–3 cm. long, covered by an evident brown false membrane which flakes away revealing a dark brown, granular spore mass surrounding a well developed, much branched, columella ; sterile cells globose–subglobose, hyaline, usually in groups or chains, angular by compression, variable in size, 8–14 μ diam. ; spores globose–subglobose, semi-regular, light reddish-brown, 7–10 μ diam., medium echinulate under oil immersion.

Type host and locality : On *Cymbopogon* sp., Vryburg, Cape Province, Union of South Africa.

On Andropogoneae : *Cymbopogon* sp., Cape Province (M.H. 20666).

Distribution : Reported only from type locality.

Sphacelotheca Pappophori (Pat.) Zundel n.n.

Ustilago Pappophori Pat. Bull. Soc. Myc. (France) **22** : 199. 1906.

Ustilago Pappophori Sydow, Ann. Myc. **24** : 265. 1926.

Sori in the ovaries, causing complete destruction, ovoid, about 1–1.5 by 5–8 mm., covered by a false membrane which flakes away as sterile cells revealing a dark brown spore mass surrounding a columella ; sterile cells abundant, subglobose–ellipsoidal, often irregular, about the size of the spores, singly or in groups, hyaline or tinged yellow ; spores globose–subglobose, occasionally ellipsoidal, light olivaceous-brown with a narrow, dark, reddish-brown epispore, 7–11 μ diam., finely but abundantly verruculate.

Type host and locality : On *Pappophorum scabrum* Kunth, Selah ad Ahaggar, Algeria.

On Festuceae : *Enneapogon* sp. (M.H. 17279), South West Africa ; *Pappophorum scabrum* Kunth,* South Africa.

Distribution : Algeria, Tunis, South Africa.

Sphacelotheca Nyassae (H. and P. Sydow) Zundel, Mycologia **22** : 133. 1930.

Ustilago Nyassae H. and P. Sydow, Ann. Myc. **18** : 156. 1920.

Sori in the ovaries which remain about normal size, inconspicous, concealed by the glumes, 5 mm. long, covered by an evident false membrane which ruptures revealing a brown, powdery spore mass surrounding a simple columella ; false membrane disintegrating into hyaline, globose sterile cells, 11–16 μ diam. ; spores globose–subglobose, sometimes angular, reddish-brown, 9–12 μ diam., under oil immersion finely verruculose and coarsely vacuolated.

Type host and locality : On *Andropogon* sp., Nyassa-Hochland, Station Kyimbila, Nyasaland Protectorate.

On Andropogoneae : *Andropogon* sp., Nyasaland Protectorate.

Distribution : Not reported except from type locality.

Sphacelotheca monilifera (Ellis and Ev.) G. P. Clinton, Jour. Myc. **8** : 141. 1902.

Ustilago monilifera Ellis and Ev. Bull. Torrey Club **22** : 362. 1895.

Sori in the ovaries of the spikelets, 5–7 mm. long or about the length of the glumes, at first concealed by the glumes, covered with an evident false membrane that flakes away revealing a brownish-black spore mass with evident columella ; cells of the false membrane

adhering semi-permanently, interior sterile cells globose subglobose, singly, in pairs or in groups, 9–14 μ diam., tinted light yellowish-brown; spores globose-subglobose, usually regular but sometimes angular, olivaceous-brown, 9–14 μ diam., under oil immersion minutely verruculose or echinulate.

Type host and locality: On *Heteropogon contortus* (L.) Roem. et Schultz (=*Andropogon contortus* Linn.), Tucson, Arizona, United States.

On Andropogoneae: *Heteropogon contortus* (Linn.) Roem. et Schultz, Tanganyika Territory.

Distribution: South-Western United States, Mexico, Hawaii, Tanganyika Territory

Sphacelotheca pretoriense (Pole-Evans) Zundel n.n.

Ustilago pretoriense Pole-Evans, Ann. Myc. **12**: 263. 1914.

Sori destroying the inflorescence, 1.5–2 cm. long, tubular, covered with a dark brown membrane which dehisces apically revealing a brown spore mass surrounding a well formed columella; sterile cells 7–13 μ diam., globose–ellipsoidal, somewhat irregular, usually granular, hyaline; spores globose—broadly ellipsoidal, regular light reddish-brown, 7–13 μ diam. but chiefly 10–13 μ, echinulate to spiny.

Type host and locality: On *Urochloa helopus* Stapf, Pretoria, Transvaal, (M.H. 7408)

On Paniceae: *Urochloa helopus* Stapf. (=*Panicum Helopus* Trin.), Transvaal (M.H. 7799, 8926).

Distribution: Transvaal.

Sphacelotheca modesta (Sydow) Zundel n.n.

Ustilago modesta Sydow, Ann. Myc. **33**: 231. 1935.

Sori in the ovaries, causing complete destruction, covered by a delicate yellowish membrane which flakes away as sterile cells disclosing a dark brown spore mass surrounding a columella; sterile cells abundant, subglobose–ellipsoidal, singly, in pairs or in chains, hyaline, vacuolated, usually 5 × 7 μ, occasionally larger; spores globose–subglobose, rarely ellipsoidal, olivaceous-brown with a reddish-brown epispore, 10–14 μ diam., abundantly but minutely verruculose.

Type host and locality: On *Enneapogon brachystachyus* Stapf, Prieska, Cape Province Union of South Africa.

On Festuceae: *Enneapogon brachystachyus* Stapf, Cape Province (M.H. 23506).

Distribution: Reported only from type locality.

Sphacelotheca flagellata (Sydow) Zundel n.n.

Ustilago flagellata Sydow, Ann. Myc. **9**: 144. 1911.

Sori destroying the inflorescence, forming along the rachis as a long columella, 8–30 cm. long, at first covered by a brown membrane which later flakes away as sterile cells and revealing a dark brown spore mass; spores globose–subglobose, dark brown, 10–14 μ diam., minutely echinulate; sterile cells globose–subglobose, in groups or chains, hyaline, 10–14 μ diam.

Type host and locality: On *Rottboellia exaltata* Linn., Province Rizal, Luzon, Philippine Islands.

On Andropogoneae: *Rottboellia exaltata* Linn., Tanganyika Territory; *Rottboellia compressa* Linn. f. Transvaal (M.H. 20331.)

Distribution: Philippine Islands and Tanganyika Territory, South Africa.

This species differs from *Sphacelotheca columellifera* (Tul.) Cif. mainly in having larger darker coloured and finely echinulate spores.

Sphacelotheca Stuhlmanni (P. Henn.) Zundel, Mycologia **22**: 136. 1930.

Sori in the ovaries, long linear, usually 7–10 cm. long, covered with an evident brown false membrane which flakes away disclosing a brown, somewhat agglutinated spore mass

sterile tissue disintegrating into large groups of sterile cells ; often in chains which sometimes collapse, tinted brown ; spores globose–subglobose, sometimes angular, thick walled, reddish-brown, 9–14 μ diam., under oil immersion minutely echinulate.

Type host and locality : On *Andropogon* sp., Ukami, Mrigogo, Central Africa.

On Andropogoneae : *Andropogon* sp., Tanganyika Territory.

Distribution : Central Africa and Tanganyika Territory.

Melanopsichium G. Beck, Ann. Nat. Hofmus. Wien **9** : 122. 1894.

Sori on various parts of the host, firmly agglutinated and conspicuous spore masses ; spores simple, developed in irregular chambers or groups arising from a mixture of plant tissue and fungous threads, thus giving a tubercular character to the sorus, enveloped by a more or less permanent gelatinous envelope, discharging from spore mass by absorption of water, of medium size ; germination as in *Ustilago*.

Type : *Ustilago austro-americanum* Speg.[1], on *Polygonum incarnatum* auct., [2]Missouri, United States. (Rabenh. Fungi Eur. No. **3501**.)

Melanopsichium austro-americanum (Speg.) G. Beck, Ann. Nat. Hofmus. Wien **9** : 122, 1894.

Ustilago austro-americanum Speg. Anal. Soc. Ci. Argent. **12** : 63. 1881.

Sphacelotheca austro-americanum Liro, Anal. Acad. Sci. Fennicae, Ser. A., **17** : 124. 1924.

Sori usually in the inflorescence, occasionally on the leaves and then smaller, forming irregular lobed masses arising from fusion of infected parts, forming a hard agglutinated spore mass mixed with plant tissue ; spores subglobose–ellipsoidal, often irregular with more or less evident gelatinous envelopes, light golden brown, chiefly 7–14 μ diam., smooth.

Type host and locality : On *Polygonum acre* HBK., Argentina.

On Polygonaceae : *Polygonum lapathifolium* L. v. *glabrum* Burtt Davy, Natal (M.H. 20435).

Distribution : North America, South America, Europe, Asia, Africa.

The South African specimen is a rather unusual form with the sori on the leaves.

Cintractia Cornu, Ann. Sci. Nat. VI. **15** : 279. 1883.

Anthracoidea Bref. Unters. Gesammt. Myk. **12** : 144. 1895.

Sori on various parts of the host, often in the ovaries, forming a black, usually rather firm, agglutinated, spore mass : spores simple, usually of medium or large size and of reddish-black colour, formed in a centripetal manner from fertile stroma usually surrounding a central columella of plant tissue, often freed from sorus by absorption of water ; germination apparently of a modified *Ustilago* type.

Type : *Ustilago axicola* Berk., on *Cyperus* sp.[3], North America.

Cintractia Melinis Zundel n. sp.

Sori destroying the ovaries, about 1 mm. long, at first agglutinated but later somewhat powdery ; spores globose–ellipsoidal, irregular, somewhat angled, reddish-brown, 7–11 μ diam., apparently smooth but minutely echinulate under oil immersion lens.

Hab. in ovaries of *Melinis tenuinervis* Stapf, Capetown, Cape Province, Union of South Africa, Coll. C. W. Malley, June 12, 1914. M.H. **19860**.

Latin description :—

Soris ovaria destruentibus, ca. 1 mm., primum conglutinatis, deinde subpulverulentis ; sporis globosis v. ellipsoideis, irregularibus, subangularibus, rubro-brunneis, 7–11 μ diam., specis levibus sed minute echinulatis (sub oleo visis).

Hab. in ovariis *Melinis tenuinervis* Stapf, Capetown, Cape Province, in Unione Africae australis, Coll. C. W. Malley, June 12, 1914. M.H. **19860**.)

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[1] The original type of *U. austro-americanum* was described form South America by Spegazzini in Anal. Soc. Ci. Argent. **12** : 63. 1881.

[2] *Polygonum incarnatum* Auct. is now considered to be *P. lapathifolium* Linn.

[3] Clinton suggests, Proc. Boston Soc. Nat. Hist. **31** : 397. 1904, that this was really *Fimbristylis*.

Sorosporium Rudolphi, Linnaea **4** : 116. 1829.

Sori in various parts of the host, forming dusty dark coloured spore masses ; spore balls composed of numerous fertile cells ; often rather loosely united and frequently at maturity completely separating, of medium size ; spores usually olive or reddish-brown, of medium size ; germination similar to that of *Ustilago*, sometimes with elongated germ thread and no sporidia.

Type : *Sorosporium Saponariae* Rud., on *Saponaria officinalis*, Germany.

* Spores smooth.

Sorosporium pretoriaense Zundel, Mycologia **22** : 146. 1930.

Sori in the inflorescence, 3–8 mm. long, broad at the base, covered by a delicate false membrane which flakes away revealing a brown granular spore mass surrounding a well developed columella ; spore balls broadly ellipsoidal, opaque, dark reddish-brown, many spored, temporary, usually 38–66 μ, rarely 85 μ diam. ; spores globose-subglobose, light olivaceous- brown with a thick yellowish wall, 5–7 μ diam., smooth, contents granular to vacuolated.

Type host and locality : On *Cymbopogon plurinodis* Stapf, Pretoria, Union of South Africa.

On Andropogoneae : *Cymbopogon plurinodis* Stapf, Transvaal (M.H. 10045).

Distribution : Reported only from type locality.

Sorosporium Holstii P. Henn. Pflanzenw. Ost-Afrikas Nachb. C : 49. 1895.

Sori in the inflorescence, long linear, 7 mm. long, covered by an evident false membrane which flakes away revealing a brown granular spore mass surrounding a well developed columella ; spore balls subglobose–broadly ellipsoidal, opaque, many spored, 50–114 μ diam. ; spores globose–subglobose, light reddish-brown, 5–8 μ diam., smooth.

Type host and locality : On *Themeda triandra* Forsk. (=*Themeda Forskalii* Hack.), Tanganyika Territory (German East Africa).

On Andropogoneae : *Cymbopogon elegans* Spreng., Nyasaland Protectorate ; *Themeda triandra* Forsk. (=*Themeda Forskalii* Hack.), Nyasaland Protectorate, Transvaal, Tanganyika Territory, Transvaal (M.H. 9315).

Distribution : Eastern and Southern Africa.

Sorosporium consanguineum Ellis and Ev. Jour. Myc. **3** : 56. 1887.

Ustilago Aristidae Peck, Bull. Torrey Club **12** : 35. 1885. Not *Sorosporium Aristidae* Neger.

Sorosporium Bornmulleri P. Magn., Ver. Zool.-Bot. Gesell. (Wien), **50** : 434. 1900.

Sori in the ovaries, almost entirely concealed by the glumes though often somewhat visible through them ; spore balls subglobose–broadly ellipsoidal, often irregular, at first firm but with age and in old specimens separating and becoming entirely broken down, usually 60–130 μ diam. ; spores ovoid-subglobose but chiefly polyhedral, reddish-brown, mostly 6–8 μ diam., smooth.

Type host and locality : On " *Aristida Rusbyi* " (*A. arizonica* Vasey).

On Agrostideae : *Aristida junciformis* Trin. et Rupr., Natal (M.H. 1592, 9763).

Distribution : Central and South-Western United States, Australia, South Africa.

Sorosporium Cenchri (Bref.) Zundel n.n.

Tolyposporium Cenchri Bref., Unters. Gesammt. Myk. 12 : 156. 1895.

Sori in the ovaries, destroying and filling them with spores, concealed by the glumes, covered by a membrane which breaks away revealing a granular spore mass ; spore balls subglobose–ellipsoidal frequently irregular, opaque, permanent, relatively few spored, small, 25–35 μ long, occasionally 60 μ ; spores globose–subglobose, frequently angled due to compression within the spore ball, olivaceous-brown, usually 7–8 μ diam., occasionally 10 μ, smooth.

Type host and locality : On *Cenchrus echinatus* Torrey, Rio de Janeiro, Brazil.
On Paniceae : *Cenchrus ciliaris* L., Transvaal (M.H. 8893).
Distribution : Brazil and South Africa.

Sorosporium inconspicuum (Pole-Evans) Zundel n.n.

Ustilago inconspicua Pole-Evans in herb.

Sori destroying the ovaries and filling them with a brown, granular mass of spores, about 2 mm. long ; spore balls dark-brown, opaque, many spored, semi-permanent, generally ellipsoidal or irregular, 100–120 μ long ; spores globose–subglobose, often angular, light olivaceous-brown, 7–9 μ diam., smooth.

Type host and locality : On *Digitaria monodactyla* Stapf.
On Paniceae : *Digitaria monodactyla* Stapf, Transvaal (M.H. 9416, 10716).
Distribution : Reported only from type locality.

This species is very closely related to *Sorosporium setariae* McAlpine, but differs in having smaller spores.

Sorosporium Everhartii Ellis and Gall. Jour. Myc. **6** : 32. 1890.

Uredo Syntherismae Rav. (not Schw.) Rav. Fung. Car. II. 90. 1853.
Ustilago Cesati Fisch. v. Waldh. Aperçu 25. 1877. p.p.
Tolyposporium Everhartii Diet. Nat. Pflanz. **11** : 14. 1897.

Sori in the ovules of the spikelets, long linear, 1–2 cm. long, ½ cm. wide, at first concealed by the glumes, covered with an evident false membrane which dehisces from the apex revealing a granular dark brown spore mass ; spore balls globose ellipsoidal, opaque, dark reddish-brown, rather permanent, many spored, usually 40–125 μ diam. or occasionally 140 μ ; spores globose-subglobose, somewhat irregular and angled, reddish-brown (spores on inner part of spore ball lighter coloured, sometimes almost hyaline), 7–12 μ diam., free surface of outer spores verruculose otherwise smooth.

Type host and locality : On *Andropogon virginicus* Linn., Newfield, New Jersey, United States.
On Andropogoneae : *Hyparrhenia Ruprechtii* Fourn., Transvaal (M.H. 7770).
Distribution : Eastern United States, Congo, South Africa.

Sorosporium[1] verecundum (Sydow) Zundel n.n.

Ustilago verecunda Sydow, Ann. Myc. **33** : 231. 1935.

Sori entirely destroying the ovaries, about 2 mm. long, almost entirely concealed by the glumes, covered by a lemon-yellow false membrane which flakes away revealing a dark brown agglutinated spore mass ; spore balls subglobose ellipsoidal, many spored, opaque, disintegrating at maturity, 42–66 μ long, occasionally 102 μ long ; spores globose–subglobose, somewhat angled by compression, olivaceous-brown with a narrow reddish-brown epispore, 7–12 μ diam., rarely 14 μ smooth.

Type host and locality : On *Urochloa helopus* Stapf, Wonderboom, Pretoria, Transvaal.
On Paniceae : *Urochloa helopus* Stapf, Transvaal (M.H. 26609).
Distribution : Reported only from type locality.

Sorosporium Zundelianum Ciferri, Nuovo Giron. Bot. Ital. n.s. **40** : 268. 1933.

Ustilago tumefaciens P. Henn. Pflanzenw. Ost-Afrikas C. **5** : 48. 1895.
Sorosporium tumefaciens[2] Zundel, Mycologia **22** : 149. 1930. p.p.

Sori destroying the inflorescence, concealed by the glumes, 1–2 cm. long, long linear somewhat tubular, covered by an evident false membrane which flakes away disclosing

[1] In order to find spore balls it is necessary to secure material from the base of the sorus. The spore balls at the tip of the sorus are usually entirely disintegrated.

[2] Not *Sorosporium tumefaciens* McAlpine, Smuts of Austr. 184, 1910, (on *Stipa* sp. and *Stipa pubescens* R. Br. in Queensland, Australia).

a dark brown granular spore mass; spore balls globose ellipsoidal, irregular, opaque, dark brown, many spored, semi-permanent (may be almost entirely disintegrated in old mature specimens), 35–95 μ long; spores globose ellipsoidal, irregular, often angular, 9–12 μ diam., outer spores echinulate to verruculate on free surface, inner spores mostly smooth.

Type host and locality: On *Hyparrhenia rufa* Stapf (= *Andropogon rufus* Kunth), Kilimandscharo, Rombo, Tanganyika Territory (formerly German East Africa).

On Andropogoneae: *Hyparrhenia rufa* Stapf (= *Andropogon rufus* Kunth), Tanganyika Territory; *Hyparrhenia Tamba* Anders., Natal (M.H. 14167).

Distribution: Southern and Eastern Africa.

Sorosporium Tembuti P. Henn. and Pole-Evans, Bot. Jahrb. (Engler) **41**: 270. 1908.

Sori destroying the inflorescence, 1–3 cm. long or occasionally slightly longer, covered by a false membrane which flakes away revealing a dark brown granular spore mass surrounding a well developed columella; spore balls globose–oblong, opaque, with 60 or more spores, dark brown, 40–90 μ diam.; spores globose–subglobose, sometimes angled, medium to light reddish-brown (spores on inner part of spore ball lighter in colour), 9–11 μ diam. rarely 14 μ, outer spores echinulate on free surface, inner spores smooth.

Type host and locality: On *Hyparrhenia Tamba* Anders., Waterval Onder, Transvaal. (M.H. 169).

On Andropogoneae: *Hyparrhenia Tamba* Anderss. Transvaal (M.H. 169, 1794, 1849).

Distribution: South Africa.

Sorosporium setariae McAlpine, Smuts of Australia 183. 1910.

Sori in the ovaries filling them with a brown mass of spores; spore balls dark-brown, opaque, many spored, variously shaped, globose–subglobose to ellipsoidal, often angled, usually 85–125 μ long, occasionally 160 μ long, semi-permanent; spores globose–subglobose often angular, light olivaceous-brown, 10–12 μ diam., smooth.

Type host and locality: On *Setaria glauca* Beauv., near Cloncurry, Queensland, Australia.

On Paniceae: *Setaria perennis* Hack., Transvaal (M.H. 17269).

Distribution: Australia, South Africa.

This species differs from *Sorosporium inconspicua* (Pole-Evans) Zundel principally by the larger spores.

** Spores not smooth.

Sorosporium austro-africanum Zundel, Mycologia **22**: 147. 1930.

Sori in the inflorescence, long linear, 5–8 mm. long, solitary, covered by an evident yellowish false membrane which dehisces at the apex disclosing a granular spore mass surrounding a well developed columella; spore balls semi-opaque, broadly ellipsoidal, usually 142–190 μ in length but occasionally as small as 47 μ, semi-permanent, many spored, reddish-brown; spores globose–subglobose, irregular, often somewhat angular, light reddish-brown to almost hyaline, thick walled, 6–10 μ diam., usually smooth except spores on the outer portion of spore ball which are verruculose.

Type host and locality: On *Hyparrhenia tampa* Anders., Tugela River, Natal, Union of South Africa.

On Andropogoneae: *Hyparrhenia tamba* Anders., Natal (M.H. 14168).

Distribution: Reported only from type locality.

Sorosporium Healdii Zundel, Mycologia **22**: 147. 1930.

Sori in the inflorescence, concealed by the glumes, attacking the individual flowers and en masse producing a witches' broom-like growth, 2–3 cm. long, covered with a yellowish brown false membrane which dehisces from the apex revealing numerous shreds and a dark brown granular spore mass surrounding a well formed columella; spore balls globose–

broadly ellipsoidal, somewhat irregular, opaque, dark brown, permanent, 30 or more spores, usually 40–70 μ long but occasionally 90 μ long; spores globose–subglobose or broadly ellipsoidal, reddish-brown for the outer spores to almost hyaline for the spores on the inner part of the spore ball, thick walled, 6–10 μ diam., sparingly verruculose under oil immersion.

Type host and locality: On *Hyparrhenia* sp., Pretoria, South Africa.

On Andropogoneae: *Hyparrhenia* sp., Transvaal (M.H. 9732).

Distribution: Transvaal.

Sorosporium afrum Sydow, Ann. Myc. **33** : 232. 1935.

Sori entirely destroying the panicles, covered by a brown membrane which ruptures revealing numerous black shreds and spore balls intermixed, 2·5 c.m long, spore mass dark brown; spore balls globose–subglobose, dense, many spored, semi-permanent; spores globose–subglobose, somewhat angled, olivaceous-brown, 7–12 μ diam., apparently smooth but under oil immersion lens showing minute echinulations.

Type host and locality: On *Panicum laevifolium* Hack., Transvaal (M.H. 6579).

On Paniceae: *Panicum laevifolium* Hack., Natal (M.H. 11706), Transvaal (M.H. 608, 8932, 8929, 20335).

Distribution: Union of South Africa.

Sorosporium Hotsonii[3] Zundel, Mycologia **22** : 152. 1930.

Sori in the inflorescence, solitary, 3–5 cm. long, at first hidden by the outer sheath, covered by an evident false membrane which flakes away revealing a brownish granular spore mass intermixed among the shreds; spore balls globose–subglobose, semi-opaque, semi-permanent, reddish-brown, many spored, variable in size, 50–115 μ long: spores globose-subglobose, often somewhat angular, thick walled, light reddish-brown, 8–10 μ diam., under oil immersion abundantly echinulate with vacuolated contents.

Type host and locality: On *Andropogon* sp., Hopefield, Lawley, Transvaal, Union of South Africa.

On Andropogoneae: *Andropogon* sp., Transvaal (M.H. 704).

Distribution: Reported only from type locality.

Sorosporium cryptum McAlpine, Smuts of Australia 176. 1910.

Ustilago cryptum McAlpine, Proc. Linn. Soc. New South Wales **22** : 42. 1897.

Sori in the ovaries of spikelets, hidden by the glumes, about 3 mm. long, covered by a thick membrane of host tissue which ruptures revealing a black spore mass surrounding a columella of host tissue; spore balls evanescent, semi-opaque, many spored, variable in size and shape, spheroidal to ellipsoidal, 50–80 μ diam. or larger; spores globose–subglobose or sometimes ellipsoidal, regular, dark reddish-brown, 8–10 μ diam., apparently smooth but minutely echinulate under oil immersion.

Type host and locality: On *Panicum bicolor* R. Br., Braidwood District, New South Wales, Australia.

On Paniceae: *Echinochloa* sp., Transvaal (M.H. 18186).

Distribution: Australia, Union of South Africa.

Sorosporium Clintonii Zundel, Mycologia **22** : 153. 1930.

Sori in the inflorescence, large, developing in clusters as a "witches broom," large, 2–6 cm. long, and often 5 mm. wide, at first concealed by the glumes, covered with a dark brown false membrane which dehisces apically revealing a granular spore mass intermixed with shreds; spore balls globose–oblong, irregular, often angled as so to appear rectangular, opaque, permanent, many spored, dark reddish-brown, ranging from 47–133 μ long, but

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[3] In the original description the author misspelled the species name. Since the specific name is for Dr. J. W. Hotson of the University of Washington, Seattle, the name should not be *S. Hodsonii*.

mostly 66-114 μ long: spores globose subglobose, irregular, often angled, thick walled, about 1·5 μ, dark reddish-brown (spores on inner part of spore ball lighter colour, mostly tinted brown), 8–17 μ diam., verruculose on free surface.

Type host and locality: On *Hyparrhenia Tamba* Anders., Waterkloof, Pretoria, Transvaal, Union of South Africa.

On Andropogoneae: *Hyparrhenia Tamba* Anders., Transvaal (M.H. 9693).

Distribution: Reported only from type locality.

Sorosporium panici[1] MacKinnon, Jour. and Proc. Roy. Soc. N.S. Wales **46**: 210. 1912.

Sori in the ovaries, at first concealed by the glumes but later protruding, 3 mm. long, covered by a delicate membrane which flakes away revealing a granular spore mass surrounding a well formed columella; spore balls globose-ellipsoidal, somewhat irregular, 60–105 μ long, many spored, semi-permanent, in old or mature specimens almost entirely disintegrating: spores globose subglobose, irregular, somewhat angular, olivaceous-brown, 8·5-11 μ diam., densely echinulate.

Type host and locality: On *Panicum flavidum* Retz., Nyngan Experimental Farm, New South Wales, Australia.

On Paniceae: *Panicum maximum* Jacq., Rhodesia (M.H. 14000), Transvaal (M.H. 20).

Distribution: Australia, South Africa.

Sorosporium proliferatum Zundel, Mycologia **22**: 150. 1930.

Sori as large proliferations in the inflorescence resembling miniature ears of corn (maize), 2–8 cm. long, concealed by large outer glumes, covered by an evident false membrane which flakes away revealing a dark brown, granular spore mass intermixed with shreds; spore balls globose-ellipsoidal or sometimes angular, opaque, many spored, permanent, usually 45–60 μ long, occasionally 85 μ long.

The spores in the outer part of the spore ball dense, dark reddish-brown, while the inner spores are nearly hyaline, somewhat irregular in size and shape, ranging from globose–subglobose, occasionally angled, most commonly 9–12 μ diam., abundantly verruculose under oil immersion.

Type host and locality: On *Hyparrhenia aucta* (Stapf) Stent, Waterval Boven, Union of South Africa.

On Andropogoneae: *Hyparrhenia aucta* (Stapf) Stent, Transvaal (M.H. 11336).

Distribution: Reported only from type locality.

Sorosporium Reilianum (Kuhn) McAlpine, Smuts of Australia 181. 1910.

Ustilago reiliana Kuhn, Rab. Fungi Eur. **1998**. 1875.

Ustilago Reiliana Zeae Pass., Rab. Fungi Eur. **2096**. 1875.

Ustilago pulveracea Cooke, Grevillea **4**: 115. 1876.

Cintractia Reiliana G. P. Clinton, Bull. Ill. Agr. Exp. Sta. **57**: 346. 1900.

Ustilago (*Cintractia*) *Reiliana foliicola* Kell., Ohio State Univ. Natural. **1**: 9. 1900.

Sphacelotheca Reiliana G. P. Clinton, Jour. Myc. **8**: 141. 1902.

Sori occurring in either ♂ or ♀ inflorescence, usually causing complete destruction, covered with an evident membrane of host tissue which ruptures disclosing a brown spore mass and numerous columellae, the sori are frequently covered by proliferations of the tassel or ear; spore balls irregular in shape, generally opaque, dark reddish-brown, easily dis-

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[1] Sorosporium Beelii Zundel nov. comb.

Sorosporium panici Beeli, Bull. Jard. Bot. Brux. **8**: 7. 1923.

Type host and locality: On *Panicum* sp., Bomba, Congo, Africa.

The name *Sorosporium panici* MacKinnon (1912) has preference over *Sorosporium panici* Beeli (1923). These species differ in size of spore balls and spores. *S. panici* MacKinnon has spore balls 60–100 μ with echinulate spores 8·5–11 μ diameter. *S. panici* Beeli has spore balls 150–180 × 100 μ with smooth spores 6–8 μ diameter. The name Sorosporium Beelii nov. comb. is therefore proposed in place of *Sorosporium panici* Beeli.

integrating at full maturity of spores: spore balls found only in young specimens, 76–150 μ diam.; spores globose–subglobose, occasionally somewhat angled, thick walled, reddish-brown, 9–14 μ diam., abundantly echinulate under the oil immersion.

Type host and locality: On *Sorghum vulgare* Pers., Cairo, Egypt.

On Andropogoneae: *Sorghum vulgare* Pers. v. *caffrorum* (Thun.) Hubb. et Rehd. (=*Sorghum caffrorum* Beauv.), Tanganyika Territory (M.H. 20645): *Sorghum halepense* Pers.*, Natal; *Sorghum* sp., Tanganyika Territory (M.H. 20651); *Zea Mays* Linn., Cape Province*, Natal*, Orange Free State (M.H. 10064), Transvaal (M.H. 11, 505, 1480, 2142, 6586).

Sorosporium Simii[1] P.Henn. and Pole-Evans, So. Afr. Jour. Sci. **12**: 543. 1916.

Sori destroying the inflorescence, long linear, 5–7 cm. long, 1–3 cm. wide, covered with a thick dark brown false membrane which flakes away disclosing a granular spore mass intermixed with numerous long shreds; spore balls globose–subglobose, not permanent, opaque, many spored; sterile tissue rather permanent but breaking up chiefly into groups or sometimes chains of sterile cells, rarely singly, tinted brown or dark brown; sterile cells about the size of the spores; distinctive globose groups of sterile cells consisting of 4–6 cells are scattered through the sori, 19–36 μ diam.; spores globose–subglobose, olivaceous to reddish-brown, 9–13 μ diam., under oil immersion, finely echinulate with granular contents.

Type host and locality: On *Sorghum halepense* Pers., Natal, Union of South Africa.

On Andropogoneae: *Sorghum halepense* Pers., Natal (M.H. 8978, 10031); ? *Sorghum* sp., Transvaal (M.H. 11324).

Distribution: Union of South Africa.

Sorosporium filiferum (W. Busse) Zundel.

Tolyposporium filiferum W. Busse, Arb. Biol. Abt. Landw. Forstw. Kaiserl. Gesundheit **4**: 383. 1904.

Sori destroying the ovaries, cylindrical elongate, 1–3 cm. long and 5–10 mm. wide, often curved at the end, covered by a thick membrane which ruptures apically revealing long dark brown shreds and a granular spore mass; spore balls subglobose–oblong, opaque, rather permanent, many spored, dark brown, 55–115 μ long; spores globose–subglobose, inner spores light yellowish brown, outer spores dark brown, 9–14 μ diam., inner spores smooth, outer spores papillate on free surface.

Type host and locality: On *Sorghum* cult., Kenya Colony.

On Andropogoneae: *Sorghum vulgare* Pers. v. *caffrorum* (Thun.) Hubb. et Rehder., Union of South Africa.

Distribution: Africa.

Sorosporium versatilis (Sydow) Zundel n.n.

Ustilago versatilis Sydow, Ann. Myc. **33**: 231. 1935.

Sori entirely destroying the inflorescence, oblong, 2–3 cm. long, at first covered by a brownish membrane which dehisces apically revealing a dark brown agglutinated spore mass and elator-like shreds; spore balls permanent, many spored, opaque, usually ovoid but sometimes irregular, usually 65–100 μ long; spores globose–subglobose, somewhat angled due to compression, 10–13 μ diam., dark reddish-brown, under oil immersion abundantly but minutely verruculose.

Type host and locality: On *Panicum longijubatum* Stapf. (=*Panicum proliferum* Lam. var. *paludosum* Stapf.).

On Paniceae: *Panicum longijubatum* Stapf., Cape Province (M.H. 9550.).

Distribution: Reported only from type locality.

[1] *Sorosporium Simii* is probably related to but very distinct from *Sorosporium reilianum* by the possession of large groups or chains of sterile cells throughout the sori. These groups of sterile cells are very distinctive and usually consist of from four to six cells. The sterile cells found in *Sorosporium reilianum* are from the disintegration of the false tissue that surrounds the sori, and are not scattered through the sorus.

Sorosporium Maranguenense P. Henn., Pflanzenw. Ost-Afrikas Nachb. C : 49. 1895.

Sori in the inflorescence, at first covered by the leaf sheaths but later protruding, 3–6 cm. long, covered by an evident membrane which flakes away revealing a granular spore mass intermixed with shreds ; spore balls subglobose, angular, many spored, semi-permanent, 35–65 μ long ; spores subglobose, angular, irregular, thick walled, light reddish-brown (almost a yellow), inner spores lighter coloured, the thick wall dark reddish-brown, 10–14 μ diam., verruculose on free surface.

Type host and locality : On *Hyparrhenia Tamba* Anderss. (=*Andropogon lepidus* Nees), Tanganyika Territory (German East Africa).

On Andropogoneae : *Hyparrhenia Tamba* Anderss., Tanganyika Territory.

Distribution : Reported only from type locality.

Sorosporium pseudomaranguense Zundel n.sp.

Sori in the inflorescence, 3–5 cm. long, at first concealed by the sheath, later the tips protrude, covered by an evident membrane which flakes away revealing a dark brown spore mass ; spore balls ovoid–ellipsoidal, dense, many spored, semi-permanent, 35–85 μ diam. ; spores subglobose, angular, irregular, olivaceous-brown with a thick reddish-brown epispore, 10–14 μ diam., outer spores densely verruculose on the free surface, inner spores smooth.

Hab. in the inflorescence of *Andropogon* sp., Mooi River, Natal, Union of South Africa, Coll. A. O. D. Mogg, March 21, 1917. (M.H. 10073.) Host det. by Agnes Chase, Smithsonian Institute, Washington, D.C.

This species is closely related to *Sorosporium maranguensis* P. Henn.

Latin description :—

Soris in inflorescentia, 3–5 cm. longis, primum spatha tectis, deinde apicibus protrudentibus, membrana conspicua tectis, membrana decadenti et atro-brunneum sporarum globum revelante ; glomerulis sporarum ovoideis v. ellipsoideis, densis, multisporis, semi-permanentibus, 35–85 μ diam. ; sporis subglobosis, angularibus, irregularibus, olivaceo-brunneis, 10–14 μ diam. ; episporio denso, irregulari, rubus-brunneo ; sporis externis in superficie dense verruculosis, sporis internis levibus.

Hab. in inflorescentae *Andropogonis* sp., Mooi River, Natal, in Unione Africae australis. Hospes ab Agnes Chase det.

Sorosporium Flanaganianum Zundel, Mycologia **22** : 155. 1930.

Sori in the inflorescence, broad, long linear, 2–4 cm. long, solitary, covered by a thick brown false membrane which flakes away revealing a brown granular spore mass intermixed with fine shreds ; spore balls globose–subglobose, semi-permanent, opaque, dark reddish-brown, usually 75–95 μ long, rarely as small as 47 μ, spores subglobose, irregular, angular, reddish-brown, 10–14 μ diam., echinulate under oil immersion.

Type host and locality : On ? *Andropogon* sp., Emmasdale, Heidelberg, Transvaal, Union of South Africa.

On Andropogoneae : ? *Andropogon* sp., Cape Province (M.H. 9423), Transvaal (M.H. 713).

Distribution : South Africa.

Sorosporium harrismithense Zundel, Mycologia **22** : 154. 1930.

Sori in the inflorescence, 3–4 cm. long, 5–6 mm. wide, solitary, covered by a brown false membrane which dehisces apically revealing a granular spore mass intermixed with numerous shreds ; spore balls globose–subglobose, opaque, semi-permanent, dark reddish-brown, 47–105 μ long ; spores globose–broadly ellipsoidal, angular, thick walled, reddish-brown, 10–14 μ diam., echinulate under oil immersion.

Type host and locality : On *Panicum laevifolium* Hack., Harrismith, Union of South Africa.

On Paniceae : *Panicum laevifolium* Hack., Orange Free State (M.H. 1473).

Distribution : South Africa.

Tolyposporium Woronin, Abh. Senck. Nat. Ges. **12**: 577. 1882.

Sori usually in the inflorescence, more especially in the ovaries, forming a granular spore mass at maturity; spore balls dark coloured, composed of numerous spores permanently united, of medium size; spores bound together by ridged folds or thickenings of their outer walls, of small to medium size; germination about as in *Ustilago*.

(Upon rupture, by pressure, of the spore balls the thickenings or ridges often show as reticulations or as spine-like processes at the margins of the lighter coloured spores. There is a tendency to put species of *Sorosporium* with rather permanent spore balls into this genus.)

Type: *Sorosporium Junci* Schröt., on *Juncus bufomius* Linn., Germany.

Tolyposporium tristachydis (Sydow) Zundel n.n.

Sorosporium tristachydis Sydow, H. & P. Bot. Jahrb. (Engler) **45**: 263. 1910.

Sori in the ovaries, hidden by the outer glumes, at first covered by a delicate membrane which ruptures revealing a granular spore mass; spore balls permanent, held firmly together by outer folds in the spores, many spored, globose to ellipsoidal, dark reddish-brown, usually 50–80 μ diam., occasionally 109 μ; spores globose–subglobose or ellipsoidal, somewhat angular, reddish-brown (spores on the inner part of the spore balls lighter coloured), 10–15 μ diam., smooth.

Type host and locality: On *Tristachya* sp., Leimde, Cameroon, Africa.

On *Tristachya Rehmanni* Hack., Transvaal (M.H. 9436).

Distribution: Africa.

A portion of the type specimens from the Clinton herbarium has been used for this description.

Family II.—TILLETIACEAE.

Tilletia Tulasne Ann. Sci. Nat. Bot. III. **7**: 112–113. 1847.

Sori in various parts of the host, usually in the ovaries but occasionally on the leaves, forming a dusty spore mass; spores simple, usually formed singly in the ends of the mycelial threads that disappear more or less completely through gelatinization, of medium to large size; germination usually by a short non-septate promycelium which bears a terminal cluster of elongated sporidia that usually fuse in pairs which may, in nutrient solution, give rise to a considerable mycelium bearing secondary air conidia.

Spores are formed from hyphae, which swell up in a gelatinous manner.

Type *Uredo Caries* DC. on *Triticum vulgare* Linn., Europe.

Tilletia foetans (B. & C.) Trel. Wisc. Acad. Sci. Trans. **6**: 139. 1886.

Ustilago foetans Berk. & Curt. Rav. Fungi Carol. **100**. 1860.

Ustilago foetans Berk. & Curt. Hedwigia **3**: 59. 1874.

Tilletia laevis Kuhn, Rabenh. Fungi Eur. **1697**. 1873.

Sori in the ovaries, foetid, ovate-oblong, 5–7 mm. diam., protruding between the protecting glumes, when ruptured revealing a brownish spore mass; spores globose–subglobose or elliptical, often somewhat angled, light to dark olivaceous-brown, 16–21 μ diam., smooth.

Type host and locality: On *Triticum vulgare* Vill., North Carolina, United States.

On Hordeae: *Triticum vulgare* Vill., Cape Province, Transvaal (M.H. 1909).

Distribution: Co-extensive with cultivated wheat.

Tilletia heterospora (P. Henn.) Zundel n.n.

Ustilago heterospora P.Henn. Pflanzenw. Ost-Afrikas Nachb. C. **5**: 48. 1895.

Tilletia Ayresii Berk.[1], Massee in Bull. Misc. Inf. Kew 153 : 146. 1889. (Type on *Panicum maximum* Nees, hill above Port Lewis, Mauritius. Ayes No. **4754**. Type in Kew Herbarium.)

Sori in the ovaries, ovoid, inflated, 3–5 mm. diam., covered by an olivaceous, leathery membrane which ruptures revealing a dark olivaceous, semi-agglutinated spore mass; sterile spores globose–subglobose, hyaline, spiny, of two general sizes, 10–12 μ and 19–21 μ diam.: bifurcate conidiophores abundant: spores globose–subglobose, regular, light olivaceous-brown, usually 13–16 μ diam., coarsely echinulate to spiny.

Type host and locality: On *Panicum maximum* Nees, Tanganyika Territory.

On Paniceae: *Panicum laevifolium* Hack., Transvaal (M.H. 7); *Panicum maximum* Jacq., Mauritius, Natal (M.H. 15443, 17081), Portuguese East Africa (M.H. 8399), Rhodesia, Tanganyika Territory; *Panicum* sp., Transvaal (M.H. 11717).

Distribution: Africa, Islands of Indian Ocean.

Tilletia Tritici (Bjerk.) Wint. Rab. Krypt.-Fl. **11** : 110. 1881.

Lycoperdon Tritici Bjerk. Kgl. Schmed. Akad. Wiss. Abhandl. **37** : 326. 1775.
Uredo caries DC. Fl. Fr. **6** : 78. 1815.
Caeoma segetum Nees, Syst. Pilze **1** : 14. 1817.
Uredo sitophila Ditm. Sturm's Deuts. Fl. III. **1** : 69. 1817.
Uredo foetida Bauer, Ann. Sci. Nat. Bot. I. **2** : 167. 1884.
Caeoma sitophilum Link, Willd. Sp. Pl. **62** : 2. 1825.
Erysibe foetida Wallr. Fl. Crypt. Germ. **2** : 213. 1833.
Tilletia caries Tul. Ann. Sci. Nat. Bot. III. **7** : 113. 1847.
Ustilago sitophila Bon. Kennt. Con. Crypt. 27. 1860.

Sori in the ovaries, showing between the glumes, 5–6 mm. long, upon rupturing disclosing a reddish-brown spore mass; sterile cells few, subglobose, hyaline, thin walled, 14 μ diam.; spores globose–subglobose, regular, light to dark olivaceous brown, 16–20 μ diam. or slightly larger occasionally, winged reticulations about 1 μ high and 2–3 μ broad.

Type host and locality: On *Triticum vulgare* Vill., Sweden.

On Hordeae: *Triticum vulgare* Vill., Cape Province, general through region.

Distribution: Co-extensive with cultivated wheat.

Tilletia Viennotii Syd. Ann Myc. 35; 2589 25, 1937.

Sori filling the ovaries with a dark coloured spore mass, diseased ovaries larger than normal ones, hidden by the glumes; spores globose–subglobose, regular, with irregular polygonal reticulations, dark reddish-brown, 18–25 μ diam., reticulations projecting on the margin of the spores, 3–3·5 μ.

Type host and locality: *Briza maxima* Linn., Madeira Islands.

On Festuceae: *Briza maxima* Linn., Capetown, (M.H. **14679**).

Distribution: Madeira Islands, South Africa.

Tilletia transvaalensis Zundel, Mycologia **23** : 299. 1931.

Sori in the ovaries, about 1 mm. long, at first concealed by the glumes but later the tip protrudes slightly, infected spikelets scattered throughout the panicle; hyaline sterile cells smaller than the spores; spores globose–subglobose, regular, yellowish to reddish-brown, 20–26 μ diam., abundantly echinulate under oil immersion.

Type host and locality: On *Eragrostis aspera* Nees, Mucklenburg, Zebediela, Transvaal, Union of South Africa.

On Festuceae: *Eragrostis aspera* Nees, Transvaal (M.H. 25463).

Distribution: Reported only from type locality.

[1] Miss E. M. Wakefield first called attention to the fact that *Ustilago heterospora* P. Henn. and *Tilletia Ayresii* Berk. were identical in "Notes on Uganda Fungi," Bull. Misc. Inf. Kew 9 : 290, 1920. Berkeley, however, was correct in considering the fungus a *Tilletia*, in Massee, George "A Revision of the Genus Tilletia" Bull. Misc. Inf. Kew 153 : 146, 1899. The Royal Botanic Gardens, Kew, kindly supplied type material of *Tilletia Ayresii* Berk. for examination.

Tuburcinia (Fries)[1] Woronin, emend. Abh. Sensk. Nat. Ges. **12** : 561. 1882. (Fries, Syst. Myc. 3 : 439. 1829.)

Sori usually in the leaves or stems, forming dark coloured often papillate areas, rather permanently embedded in the tissues ; spore balls composed entirely of firmly united fertile cells ; of medium size ; spores usually dark coloured, variable, of medium size ; sometimes preceded by conidia[2], forming a conspicuous white growth on the surface of leaves, hyaline, oblong to ovate.

Type : *Tuburcinia Trientalis* B. & Br., on *Trientalis europaea* Linn., Europe.

To date no species of this genus have been reported from South Africa. They are usually found in cold climates.

Urocystis Rabenhorst, Klotsch, Herb. Viv. Myc. ed. 2. 393. 1856.

Polycystis Lev. Ann. Sci. Nat. III. **5** : 269. May 1846, not *Polycystis* Kutz, Jan. 1846.

Sori usually in the leaves or stems, occasionally in other parts, producing dark coloured usually dusty spore masses ; spore balls permanent, composed of an enveloping cortex of tinted sterile cells and from one to several interior fertile cells, of small to medium size ; spores usually dark coloured, variable, of medium size ; the balls of spores are developed inside coils of hyphae, which become entwined together and swell up in a gelatinous manner ; the central spores on germination give rise to a promycelium, with terminal sporidia which do not as a rule fuse in pairs, but grow out directly into mycelia.

Type : *Erysibe occulta* Wallr., on *Secale cereale* Linn., Europe.

Urocystis Tritici Koern. Hedwigia **16** : 33. 1877.

Tuburcinia tritici Liro, Ann. Univ. Fenn. Aboensis, Ser. A. **1** : 17. 1922.

Sori in the leaves, culms and leaf sheaths as long striae, covered by a leaden coloured membrane which when ruptured reveals a dark brown spore mass ; spores variable in shape, globose–ellipsoidal, often irregular, usually with 1–2 fertile spores, sometimes 3–4, rarely 5, dark reddish-brown surrounded by lighter coloured sterile cells, chiefly 24–32 μ diam. ; spores globose–ellipsoidal, dark reddish-brown, 10–17 μ diam., smooth ; sterile cells usually completely enveloping fertile spores, globose–ellipsoidal, pale yellow, 7–12 μ diam., smooth.

Type host and locality : On *Triticum vulgare* Vill., New Holland, Australia.

On Hordeae : *Triticum dicoccum* Schrank.* : Cape Province ; *Triticum durum* Desf.*, Cape Province ; *Triticum turgidum* Linn.*, Cape Province ; *Triticum vulgare* Vill., Cape Province, Transvaal (M.H. 12454, 13050, 13049).

Distribution : Australia, South Africa, Central United States, Japan, India, Egypt, China.

Urocystis Ornithoglossi (Sydow) Zundel n.n.

Tuburcinia Ornithoglossi Sydow, Ann. Myc. **33** : 233. 1935.

Sori in the leaves as inconspicuous lead coloured pustules about 2 mm. long, sometimes becoming confluent and then longer, covered by the epidermis, spore mass dark brown, granular ; spore balls usually with one (rarely two or three) spore entirely surrounded by numerous outer sterile cells, usually 17–24 μ diam., rarely 31 μ ; outer sterile cells globose–subglobose, light olivaceous-brown, about 7 μ diam. ; spores globose–subglobose, dark reddish-brown, 10–14 μ diam.

Type host and locality : On *Ornithoglossum glaucum* Salisb.

On Liliaceae : *Ornithoglossum glaucum* Salisb., Transvaal (M.H. 1888).

Distribution : Reported only from type locality.

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[1] Fries in 1829 was the first to use the term *Tuburcinia* as a genus name. In 1882, Woronin emended the genus so that it did not include any of Fries' original species. In 1922, Liro (Uber de Gattung Tuburcinia Fries, Ann. Uvin. Fenn. Aboensis, A. 1: 1–153, 1922) combined the two genera *Urocystis* Rabenh. and *Tuburcinia* Woronin under the one genus *Tuburcinia* Fries. In so doing he includes species that are cytologically and morphologically dissimilar and only adds confusion to the taxonomy of the Ustilaginales.

[2] *Tuburcinia Trientalis* B. & Br. is the only species known to produce conidia.

Entyloma De Bary, Bot. Zeit. **32** : 101. 1874.

Rhamphospora D. D. Cunningham, Sci. Mem. Med. Off. Army India **3** : 32. 1888.

Sori usually in the leaves, generally forming discoloured but little distorted areas, spores simple, produced terminally or intercalary on any part of the fertile mycelium which is intercellular and never entirely disappears through gelatinization, free (sometimes adhering irregularly through pressure), hyaline to yellowish or reddish-yellow, occasionally dark coloured, of medium size; germination by a short promycelium bearing a terminal group of sporidia which usually conjugate in pairs and produce secondary sporidia or infection hyphae; conidia often present, hyaline usually elongate formed by germination of the spores in situ; or on the mycelium produced through the stomata.

Type: *Protomyces microsporus* Ung., on *Ranunculus repens*, Germany.

Entyloma Zinniae Sydow, Ann. Myc. **33** : 233. 1935.

Sori as orbicular to irregular spots in the leaves, 2–5 mm. diam., showing best on the upper surface, at first yellowish then brown; spores globose–subglobose, regular, with a regular equal epispore about 2 μ, tinged olivaceous-brown, 8–10 μ diam., occasionally 14 μ.

Type and locality: On *Zinnia pauciflora* Linn.

On Compositae: *Zinnia pauciflora* Linn., Transvaal (M.H. 14256).

Distribution: Union of South Africa.

Entyloma Bidentis P.Henn. Pflanzenw. Ost-Afrikas C. **5** : 49. 1895.

Sori in the leaves, forming roundish brown spots visible on both upper and lower surfaces, 2–3 cm. diam., often coalescing, at first yellowish then chestnut brown; spores subglobose, irregular, contents sometimes with small greenish granules, olivaceous yellow, 10–14 μ diam., epispore 1–1·5 μ thick, smooth.

Type host and locality: On *Bidens pilosa* Linn., Tanganyika Territory.

On Compositae: *Bidens pilosa* Linn., Cape Province (M.H. 8853), Tanganyika Territory, Transvaal (M.H. 1508).

Distribution: Eastern and Southern Africa.

Entyloma australe Speg. Anal. Soc. Cien. Argent. **10** : 5. July, 1880.

Protomyces Physalidis Kalchb. Grevillea **9** : 22. Sept., 1880.

Entyloma Besseyi Farl. Bot. Gaz. **8** : 275. 1883.

Entyloma Physalidis Wint. Hedwigia **22** : 130. 1883.

Sori in the leaves and often in the inflated calyx, forming at first light coloured and later darker coloured, slightly raised (on lower side of leaf) spots, roundish, often angular, 0·5–7 mm. or more in diam.; spores globose–subglobose, sometimes angled, with a thick darker coloured epispore, light reddish-brown, 10–15 μ diam., smooth; conidia forming whitish epi- or hypophyllous growth, linear, somewhat curved, usually 30–55 μ × 1–2 μ.

Type host and locality: On *Physalis hirsuta* Duncan, Argentina.

On Solanaceae: *Physalis minima* Linn., Transvaal (M.H. 1509, 5638, 11008, 14126); *Physalis peruviana* Linn., Cape Province (M.H. 10028), Transvaal.

Distribution: North America, South America, South Africa.

Entyloma Dahliae H. & P. Sydow, Ann. Myc. **10** : 36. 1919. 2

Sori as orbicular to elliptical spots on the leaves, pale but definite and conspicuous, 1–10 mm. long; spores globose, pale olivaceous-brown, evenly coloured including the epispore, 9–14 μ diam., epispore 1–2·5 μ; conidia unreported.

Type host and locality: On *Dahlia variabilis* Desf., Harden Heights, Natal, Union of South Africa.

On Compositae: *Dahlia variabilis* Desf., Natal (M.H. 86C, 19761), Transvaal (M.H. 18023).

Distribution: Europe, Central America, South Africa, South Rhodesia.

APPENDIX A.

The following species have been reported from South Africa and adjacent territory but no specimens have been available for examination.

Sphacelotheca Panici-miliacei (Pers.) Bubak, Naturw. Landes. Bòhmen **15** : **26.** 1916.
Uredo segetum panici-miliacei Pers. Synop. Meth. Fung. 224. 1801.
Uredo carbo Panici miliacei DC. Fl. Fr. **6** : 76. 1815.
Uredo destruens Duby, Bot. Gall. **2** : 901. 1824.
Erysibe Panicorum Wallr., Fl. Crypt. Germ. **2** : 216. 1833.
Ustilago Carbo destruens Lev. Ann. Sci. Nat. III. **8** : 372. 1848.
Ustilago destruens Schlecht. Rab. Herb. Myc. No. 400.
Ustilago panici-miliacei Wint. Rab. Krypt.-Fl. 11 : 89. 1881.
Sorosporium Panici-miliacei Tak. Bot. Mag. (Tokyo) **16** : 183. 1902.

Ustilago Panici-miliacei (Pers.) Wint. Die Pilze p. 89, Schroet. Pilze Schles. p. 268, Bref. Untersuch. V, pag. 97, tab. 7, fig. 9–24, *Uredo* (*Ustilago*) *segetum* var. *Panici-miliacei* Pers. Syn. Fung. p. 224, *Uredo Carbo* var. d. DC. Flor. Franc VI, pag. 76, *Caeoma destruens* Schlecht. Fl. Berol. II, p. 130, *Uredo destruens* Duby Bot. Gall. II, p. 216. n. 1670, *Ustilago Carbo* var. *destruens* Tul. Ann. Sci. Nat. III. **7** : 81. 1847, *Tilletia destruens* Lev. Ann. Sci. Nat. III. **8** : 372. 1848, *Ust. destruens* Schlecht. in Rabenh. Herb. Myc. nov. n. 400.—Soris atris, pulverulentis, flores destruentibus ; sporis globosis vel ellipsoideis, 9–12 8–10, raro angulatis, episporio flavo-brunneo levi vel punctulato instructis ; promycelio filiformi cylindraceo, plerumque 3-septulato, articulis, anastomosantibus ; oblongo-ellipticis vel ovoideis.*

Hab. in floribus paniculisque *Panici-miliacei, P. carthaginiensis* et. *P. Crus-galli*, Gallia, Germania, Amer. bor. (Ravenel) nec non pr. Montivideo Americae australis (Archa valeta sec. Winter). (Saccardo Syll. Fung. **7** : 454–455. 1888.)

Tolyposporium Anthistiriae Cobb. in Agric. Gaz. New South Wales, 1892. p. 1006, cum ic, Syll. XIV, p. 426, *Tolyposporium Anthistirae* P.Henn. Hedwigia 1898, pag. 283. – Sori in spices easque destruentibus, cylindraceis, 2–5 cm. longis, epidermide dein lacerata flavescente tectis ; glomerulis oblongis vel subglobosis aterrimis, 70–100 μ diam. ; sporis subglobosis v. ellipsoideis, primo hyalinis, dein cinnamomeis v. atris, 9–14** 8–12, episporio minutae verrucoso-punctulato, 1 μ crasso.

Hab. in spices *Anthistirae* spec. in Africa centr. (Schweinfurth) et Australia (Cobb). — Sec. Cobb loc. cit. massa sporarum 40–150 μ diam. ; cellulae singulae 8–14 μ. longa. Ergo species homonyma posterior cl. Henningsii eadem videtur. (Saccardo Syll. Fung. **16** : 378. 1902.)

Tolyposporium setariicolum H. et P. Sydow Ann. Myc. **10** : 77. 1912. Soris in spicis evolutis easque omnino destruentibus, haud tumefacientibus atris ; glomerulis rotundatis, ellipticis v. forma irregulari, 35–70 μ diam., ex sporis numerosissimis compositis, sub-firmis ; sporis angulato-globosis v. angulato-ellipsoideis, brunneis, 7–10 $\times$ 6–9, verrucis facile deciduis obsitis.

Hab. in foliis *Setariae aureae* (Graminaceae), Sidderiberg Kamerun, Africae (C. Ledermann, no. 4803, 30.7.1909) — A *Tol. pampeano* Speg. quoque in *Setaria* omnino diversum. (Saccardo Syll. Fung. **23** : 620. 1925.)

Tolyposporium Penicillariae Bref. Unters. XII. p. 154, tab. IX. fig. 35–40. — Soris in quaque spica solitariis, ovariicolis, bullam magnam globosam efformantibus, nigris, glomerulis sporarum variae magnitudinis ac formae, plerumque subglobosis v. ovoideis ; sporis solitariis dilutioribus, 10–12 μ diam., vix distincte verrucosis, flavo-brunneis ; promycelio gracili, 8-loculari ; sporidiolis capiosissimis, ad septu evolutis.

Hab. in inflorescentiis *Penicillariae spicatae*, Simla Indae Orient. (Barclay). (Saccardo Syll. Fung. **14** : 426. 1899.

Uredo pilulaeformis, n.s. ; sporis fusco-nigris irregularibus vel subglobosis regosiusculis plus minus connatis conglomeratis immixtis minoribus effaetis massam compactam non rimosam efformatibus, *Zeyher*, n. 89.

Destroying the germens of some species of *Juncus*. Uitenhage. December.

Resembling very strongly *U. urceolorum*, and, like that, infesting the germen, and forming little globose or elliptic, pill-like bodies, consisting of a compact mass of deep brown, irregular, subglobose, often angular, more or less connate, slightly rugose spores, mixed with smaller globose, sub-elliptic, hyaline bodies, which appear to be abortive sporidia. They become yellow when treated with iodine, and therefore are not fecula. In the centre of the mass, towards the base, there is sometimes a pale clavate columella, extending half way up the mass, but this is not always present. The surface of the mass is not cracked, at least in the specimens before me.

This species resembles very much *U. urceolorum*, but in that the spores are distinct and echinulate, and they are not mixed with abortive spores, or if so, in a very slight degree. The two species are certainly very nearly allied, but are, I believe, distinct. (Berkeley, M. J. Enumeration of fungi collected by Herr Zeyher in Uitenhage. Jour. Bot. (London) 2 : 523–524. 1843.) See *Cintractia piluliformis* (Berk.) P. Henn.

Ustilago Danthoniae Kalchbr. Grevillea **11** : 18. Sporis globosis 36 μ., granulosis, atro-fuscus.

Hab. in spices *Danthoniae papposae*, in summo monte Chumiberg, prope stationem Missionis evangelicae "Lovedale" dictam (Rev. T. Buchanan)—Haud procul distat *Ust.*? *Salveii*, sed haec soris linearibus folia modo occupat, non vero spicas "An potius *Tilletia* ?". (Saccardo Syll. Fung. **7** : 373. 1902.)

P. Hennings in Hedwigia **34** : 328. 1895, adds to the description of *Ust. Danthoniae* Kalchbr. as follows : "Die sporen werden von Kalchbrenner mit 36 u im Durchmesser angegeben. Dieselben sind jedoch wie bei den vorliegenden Original Examplaren, kugelig, schmutzigbraun, granulirt, 10 15 μ im Durchmesser." (Saccardo Syll. Fung. **7** : 373. 1902.)

Ustilago Dregeana Tul. in Ann. Sci. Nat. 1847, p. 83, t. III, f. 13, Fisch. Apercu p. 21.

Soris atris, deformantibus ; sporis globosis vel ovideo-obtusis, 4–5 μ diam., ex olivaceous brunneo-arantiacis, papillosus.

Hab. in pedunculis inflorescentiae graminis cujusdam in C. Bonae Spei (Drege) et *Cynodontis Dactyli* Somerset East Africae australis (Mac Owan) — Teste Kalchbrenner in Grevillea **11** : 18 inflorescentiam, adhuc in vagina latentem prorsus deformantam, fungillus pulvere atro obducit. Sed ex Kalchbrenner l.c. ; sporae sunt majores, 12–15 μ diam. leviter tuberculatae huic ad aliam speciem forte spectantes. (Saccardo Syll. Fung. **7** : 467. 1888.)

Ustilago Penniseti Rabenh. in Hedwigia 1871, pag. 18, Fisch. Apercu. p. 14, p.p. *Uredo* (*Ustilago*) *trichophora* var. *Penniseti* Kunze in Flora, 1830, p. 369, *Ustilago Carbo* 1 *columellifera* b. *trichophora* Tul. in Ann. Sci. Nat. 1847, p. 81. —

Soris clausis, firmulus, atris, colulella regida a basi divisa instructis ; sporis magnitudine diversissimis, 5·5–12 μ diam., valde irregularites globosis, saepe subangulosis, conglobatis non vel vix punctatis, episporio crassissimo, 1·8–2 μ crasso, brunneis.

Hab. in ovariis *Penniseti dichotomi, vulpini, cenchroidis* et *fasciculati* in Aegypto (Schweinfurth) et insula Maderia (Schroeter). (Saccardo Syll. Fung. **7** : 462. 1888.)

Ustilago piluliformis (Berk.) Tul. in Ann. Sci. Nat. 1847, p. 93, t. V, f. 27–30. *Uredo piluliformis* Berk. Fungi Uitehn. p. 507, t. XXII, f. 6. —

Sori compactis, atris ; sporis vel ovideo-angulatis, 16–20 × 12–16 μ diam. levibus, episporio inaequaliter incrassato, atro, partim hyalinulo.

Hab. in ovariis *Juncorum*, pr. Uitenhage in Africa meridionali (Zeyher). — A *Cintractia Junci* Trel. plane distincta. Species ob sporae maxime glomerato—coalitar, teste Tuslane firsan aptius inter *Thecaphoras militare*. (Saccardo Syll. Fung. 7 : 458–459. 1888.)

See *Cintractia piluliformis* (Berk.) P. Henn. for change of name.

Ustilago Sladenii Pole-Evans nov. spec.

Soris olivaceo-atris, pulverulentis in rachidibus floribusque, eos omnino destruentibus ; sporis globosis vel subglobosis 5–6 μ diam., glabris, dilute olivaceis.

In the flowers and branches of the inflorescence of a grass (probably *Ehrharta* sp.) Garies, 1910–11.

H. H. W. Pearson, No. **6728** (Pole-Evans No. **8409**).

Saccardo does not include this species in his Sylloge Fungorum. (South African College, Ann. Bolus Herb. **1** : 115. 1915.)

Ustilago nuda (Jens.) Kell. et Swingle II Rep. Agr. Kans. p. 215 et 277,, t. II, f. 7–17, *Ust segetum* Auct. p.p., *Ust. Hordei nuda* Jens. in litt.—

Massa sporarum brunneo-olivacea, laxa mox libera ; sporis ovoideis, ellipsoideis vel subglobosis, 5–7 × 5 × 6·5, subolivaceis, germinando promycelium parce ramosum, apicibus saepe inflatum gignentibus ; sporidiolis hucusque non visis.

Hab. in ovariis *Hordei vulgaris* in Europa amer. bor. Japonis. (Saccardo Syll. Fung. **9** : 283. 1891.)

Ustilago ugandensis P. Henn. Pilz Ostafr. p. 48. 1895.

Soris atro-olivaceis, epidermide tectis, dein cintis, pulverulentis, ad apicem culmorum in rhachibus florisbuaque, rhachidem curvam contortamque efformantibus ; sporis subglobosis, saepe acutangularis, fusco-olivaceis, sublevibus, punctulatis, 6–8 × 5–7.

Hab. in spicis *Panicum* in Africa trop. (Saccardo Syll. Fung. **14** : 414–415. 1899.)

Cintractia capensis (Reess) Ciferri, n. comb. Ann. Myc. **29** : 72. 1931.
Ustilago capensis Reess[1] in Sitzb. phys.-med. Soc. Erlangen 1875, pp. 70–72.

Ovariicola ; soris aureo-flavis, pulverulentis, sporis globosis, 15–16 μ diam., episporio reticulato, strato triplici, constituto, interiori tenui, flavido, lineolis areolisque subhyalinis.

Hab. in ovariis *Junci capensis* et *lomatophylli*, e Cap Bonae Spei proveneintium in Bremen Germanae (Buchenau).

(Saccardo Syll. Fung. 7 : 478. 1888.)

Cintractia leucoderma (Berk.) P. Henn. **34** : 335. 1895.
Ustilago leucoderma Berk. Ann. Mag. Nat. II. **9** : 200. 1852.
Cintractia Krugiana Magn. Bot. Jahrb. (Engler) **17** : 490. 1893.
Cintractia affinis Peck, N.Y. State Mus. Bull. **67** : 28. 1903.
Ustilago leucoderma Berk. Fungi S. Domingo n. 54, Fisch. Apercu p. 16. —

Soris atris maculis magnis insidentibus, consta albida inaequali subvelatis ; sporis rotundatis, rarius irregularibus, 13–17 μ diam., opacis, atris, levibus.

Hab. in vaginis foliorum *Caricis* et Cyperaceae (?) cujusdam in St. Domingo et in insula Borneo ; in vaginis *Rhynchosporae aureae* ad Ratnapoora. (Saccardo Syll. Fung. **7** : 460. 1888.)

Cintractia piluliformis (Berk.) P. Henn. Hedwigia 1898, p. 293.
Uredo piluliformis Berk. Fg. Uitenh. p. 507, t. XXII, fig. 6.
Ustilago piluliformis Tul. Ann. Sci. Nat. 1847, p. 93, t. V, fig. 27–30, Sacc. Syll. VII, p. 458. —

Soris compactis, stris, globosis, v. cylindricis, duris 1–2 mm. diam. ; sporis densis conglobatis, globosis, ellipticis v. ovoideis, initio hyalinis, intus granulatis v. punctatis, filamentis hyalinis intermixtis, dein brunneis, postremo atris, impellucidis, 10–17** 9–14.

Hab. in ovariis *Junci capensis* et *Junci* spec. in Africa austr. et meridionale. (Saccardo Syll. Fung. **16** : 373. 1902.)

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[1] Reess, Max. Ueber *Ustilago* ? *Capensis*, einem neuen Brandpilze vom Cap der guten Hoffnung. Sitzungsber. der physic.-medic. Soc. zu Erlangen **7** : 70–72, 1875.

Cintractia tangensis P. Henn. Engl. Bot. Jahrb. XXXVIII (1905), pag. 103.

Soris in axillis foliorum globosis, primo membrana hyalina vestitis, dein pulverulentis, aterrimis, 5-6 mm. c. cr.; sporis subglobosis 8-11 μ diam. v. ellipsoidesi et c. 8–12 × 7–8, μ brunneo-olivaceis, intus granulosis, episporio levi.

Hab. in axillis foliorum *Cyperi* sp., Tanga, Usambara, Africa (Tanganyika Territory). (Saccardo Syll. Fung. **21** : 510. 1912.)

Cintractia togoensis P. Henn. Engl. Bot. Jahrb. XXXVIII (1905), pag. 119.

Sori in floribus globosis, duris, atris et paucis subinclusis; sporis subglobosis v. subellipsoideis, intus granulatis, 12 14** 11–13, episporio levi, olivaceo-brunneo; hyphis hyalinis intermixtis.

Hab. in floribus *Cyperi* sp. Togo Camerum, Africae. (Saccardo Syll. Fung. **21** : 510. 1911.)

Cintractia usambarensis (P. Henn.) Ciferri, in Archiv f. Bot. (Stockholm) A. **23** : 7. 1931.
Cintractia leucoderma (Berk.) P. Henn. Hedwigia 1895, p. 335. (syn. *C. Krugiana* P. Magn.) — Var. *usambarensis* P. Henn. Pilz. Ostafr., p. 48. 1895.

Soris cylindraceis, nigris, $1\frac{1}{2}$–2 cm. longis, 14–16 mm. latis; sporis majoribus, dense verrucosis, obscurioribus, 15–17 × 14–16 μ.

Hab. in *Rhynchospora aurea* in Africa trop. (Stuhlman). (Saccardo Syll. Fung. **14** : 420. 1899.)

Sorosporium Wildemanianum P. Henn. in Fl. du Bas.-et Moy-Congo, Ann. Mus. du Congo V. II. fasc. II (1907), page. 87. —

Soris ovaria staminaque destruentibus, atris epidermide cinerea tectis; glomerulis ellipsoideis v. subglobosis e sporis numerosis compositis, 50–80 ** 50–60; sporis subglobosis v. ellipsoideis fusco-brunneis, verrucosis, 7–10 × 6–9 μ.

Hab. in foliis *Andropogonis* sp. Mbele Congo (Vanderyst). (Saccardo Syll. Fung. 21 : 513–514. 1911. Sept.)

Tuburcinia Eriospermi H. Sydow.

Pustulas orbiculares vel ellipticas 3–6 mm. longas formans; massa sporarum atra, pulverulenta; glomeruli sat regulares, globosi vel subglobosi, 16–22 μ diam., fere semper sporam unicam centralem tantum includentis; sporae globosae, fuscae, 10–13 μ diam., leves; cellulae peripherical numerosae, leves, pallide fuscae, 6-9 μ longae, 4–6 μ altae.

Hab. in foliis *Eriospermi latifolii*, Stellenbosch, 6. 1923. leg. P. A. van der Bijl (no. **1142**). (Ann. Myc. **22** : 237. 1924.)

Entyloma cissigenum P. Henn.[1] Pilz Ost-Afr. p. 49. 1895.

Maculis amphigenis, gregariis, rotundatis, circiter 2 mm. diam., saepe confluentibus, atris; sporis globosis, intus fuscis v. minute viridulis subgranulatis, 18–21 μ crasso.

Hab. in foliis vivis *Cissi* in Africa trop. (Volkens). (Saccardo Syll. Fung. **14** : 423. 1899.)

Entyloma Oleandrae P. Henn. Hedwigia 1895, p. 326.

Soris striiformibus, amphigenis, ca. 1 cm. longis, 2 mm. latis, atris v. atro-violaceis; sporis globosis, raro ellipsoideis, minute granulatis, subhyalinis, 8–12 × 6–10 μ; episporio subfuscidulo.

Hab. in foliis *Oleandrae articulatae*, Natal (Wood). (Saccardo Syll. Fung. **14** : 425. 1899.)

Urocystis Anemones (Pers.) Schröt. form kerguelensis P. Henn. Deutsche Südpolar-Exped. 1901–1903, **8** : 1. 1906.

Kerguelen—Station, an der Pinguinbucht, auf lebenden Stengeln und Blättern von *Ranunculus biternatus* Sm., Dr. E. Werth, leg. 26. Dezember 1902, 9. Januar 1903. Dieser

[1] In the original description the specific name is spelled *E. cissigena*.

in ganz Europa, Nordamerika, Sibirien usw. auf verschiedenartigen Ranunculaceen verbreitete Pilz bildet auf den niederliegenden Stengeln, Blattstielen und Blättern obiger Pflanzen aufgetriebene bis etwa 2 cm. lange, von einer graubraunen Oberhaut bekliedete Brandpusteln, welche bei der Reife durch einen Längsriss aufbrechen und die tiefschwarze Sporenmasse freilegen Dieselbe besteht aus Sporenballen von ellipsoider oder rundlicheckiger Form, die meist 20–30 u Durchmesser besitzen. In der Mitte dieser Ballen finden sich 1–3 rundlich eckige oder ellipsoide Hauptsporen, mit dunkelbrauner, undeutlich punktierter Membran, meist 12–20 u lang, 10–16 u breit. Diese werden meist von zahlreichen heller getärbeten, gelblichen, halfkugeligen oder unregelmässig eckigen, 8–12 u breiten. Nebensporen ungeben, mitunter fehlen diese ganz. Die ganze Pflanze wird durch den Parasiten untörmlich verbildet.

Durch die grösseren Hauptsporen soure durch Nebensporen ist der Pilz von der typischen Form etwas verschieden, ebense von *U. sorosporioides* Körn.

It is doubtful whether *Urocystis Anemones* form. *kerguelensis* described by P. Henning from Kerguelen Island differs from the species other than in slight variations due to host and climate. With further search, this species should be found in South Africa. Saccardo does not list this form in Sylloge Fungorum.

It must be noted that the authority for the species should be *Urocystis Anemones* Pers.) Winter; Rab. Krypt.-Fl. **11**: 123. 1881.

Tilletia Schenckiana P. Henn. Deutche Sudpolar-Exped., 1901–1903, **8**: 2. 1906.

Soris ovariicolis en destruentibus paulo deformantibus, paleis laxe circumdatis, translucentibus, ellipsoideis, firmis, membrana cinereo-fusca vestitis, ca. $1 \times 0{\cdot}5$ mm. diam.; sporis ellipsoideis vel subglobosis, 20–30 × 20–24 μ, episporio reticulato, melleo dein fusco-brunneo, ca. 2–3 μ crasso, interdum filis hyalinis, flexuosis, 2–4 μ crassis intermixtis.

Kerguelen im Tale zurschen Station und Mittelberg, in Bluten von *Deschampsia antarctica* E. Desv. Dr. E. Werth, 19 Februar 1903. Diese äussert zierliche Art tritt in den Fruchtknoten, welcher zerstört und wenig verbildet ist, in ellipsoiden, dunklen Sori von den trockenhäutigen Spelzen locker umschlossen auf und auf dem Scheitel der Sori sind oft noch die tädigen Narben erkennbar.

Der Pilz ist sowohl von *Tilletia cerebrina* Ellis et Ev. aus Nord-amerika in Ovarien von *Deschampsia caespitosa* P. B. sowie von T. *Airae Blytt* in *Deschampsia calycina* durch die kleinen sori sowie die Sporen verschieden Der Pilz wurde bei der Bestimmung der Nährpflanze bereits von Prof. Dr. Schenck beobachtet und als, *Tilletia* erkannt.

This smut described from rocky Kerguelen Island should be found in South Africa. It is not known where the type specimen is deposited. Saccardo does not list this species in Sylloge Fungorum.

APPENDIX B.

The following is a list of doubtful and excluded species that have been reported from South Africa and nearby territory.

Ustilago Welwitschiae Bres. in Sacc. Fl. mycol. Lus. p. 68. —

Soris parvis, globosis, fuligineis, pulverulentis, e squamas erumpentibus; sporis fuscidulis, globosis, asperulis, $3\frac{1}{2}$–4 μ diam.

Hab. in squamis conorum *Welwitschiae mirabilis* e Mosamedes Africae allatae in hort. bot Coimbrae (Möller). (Saccardo Syll. Fung. **14**: 411. 1899.) A doubtful smut.

Sorosporium africanum Sydow, Ann. Myc. **7**: 544. 1909.

Soris ovaria occupantibus easque omnino destruentibus, atris, pulverulentis; glomerulis esporis usque 8 compositis, 12–25 μ diam.; sporis globosis vel angulato-globosis, subtilissime verruculosis vel punctatis, olivaceis vel olivaceo-brunneis 5–9 μ diam.

Hab. in ovariis *Panici trichopi* Portugiesich-Ostafrika. 18.4.1908. leg. C. W. Howard.

The portion of the type specimen examined (M.H. **631**, on *Panicum trichopus* Hochst., Portuguese East Africa, coll. C. W. Howard, April 18, 1909) is very poor since there were very few spores and these were not typical of the Ustilaginales, much less a *Sorosporium*. A portion of the type specimen in the Clinton herbarium was examined but it contained no spores.

The original description says that the spore balls are composed of 8 spores. This is not typical of a *Sorosporium*. This fungus is apparently one of the dark spored members of the fungi imperfecti. At any rate we will list it temporarily as an excluded smut until more and better material is available for examination.

Tolyposporium Chloridis P. Henn. Pilz Ostafr. p. 49. 1895.

Soris atris, firmis, bullatis, undulato-plicatis, rugulosis, interdum confluentibus; glomerulis sporarum firmis, varia magnitudine, subglobosis, acutangulis, e 3–5 sporis compositis, 10–20 × 8–15, fusco-brunneis v. atris; sporis acutangulis, sublevibus, 6–10 μ.

Hab. in fructibus *Chloridis abysinicae* in Afric trop. (Volkens). (Saccardo Syll. Fung. 14 : 426. 1899.)

A study of specimens of *Tolyposporium Chloridis* P. Henn. from various parts of southern Africa indicates that the fungus in question is not one of the Ustilaginales but rather one of the dark coloured Hyphomycetes.

The following South African specimens from the Union Department of Agriculture, Mycological Herbarium have been examined: No. 9056, collected by I. B. Pole-Evans, Feb., 1915, at Groenkloof, Pretoria, Transvaal; No. 9770, collected by P. van der Bijl, May 5, 1926, at Mid Illovo, Natal; No. 1627, collected by E. M. Doidge, June 26, 1911, at Mountain Rise near Pietermaritzburg, Natal; No. 17043, collected by A. O. D. Mogg (no. 4290), May 1, 1919, in Zululand. In each case the host was *Chloris gayana.*

Tolyposporium Volkensii P. Henn. Pilz Ostafr. p. 49. 1895.

Soris ad germina pustulatis, submesenteriformibus, atris, subgelatinosis (?), rugulosis circ. 5–8 mm. diam.; glomerulis subglobosis v. irregulariter acutangulis, firmis, 15–28 μ diam., e 3–15 sporis compositis, plus minus fuscis; sporis subglobosis, ovoideis, oblongis, e mutua pressione acutangulis, fusco-brunneis, minute granulatis, 5–11 μ.

Hab. in ovariis *Sorghorum cultorum* in Africa trop. (Volkens).

Mason[1] (1926) worked with type material of *Tolyposporium Volkensii* P. Henn. from East Africa and found that it was not one of the Ustilaginales but was *Cerebella sorghi-vulgaris* Subram. This was later confirmed by Subramanian. "Hennings' species is a true *Cerebella* having a true convoluted stroma with a surface layer of palaside-like conidiophores each bearing at its apex a conidium with septa in three planes."

Species of the Graphiolaceae are excluded. While they are closely related to the Ustilaginales, they are not a family of this order. *Graphiola phoenicis* Poit., the most common species, attacks *Phoenix* sp. both in greenhouses and in the open.

Various species of the genera *Cerebella* and *Ustilaginoidea* are sometimes confused with the smuts. These genera are members of the family Dematiaceae of the imperfect fungi. *Tuberculina*, a member of the Tuberculariaceae of the fungi imperfecti, is another genus that is sometimes put with the Ustilaginales.

[1] Mason, E. W., on two species of *Tolyposporium* Woronin recorded on cultivated *Sorghum*. Rrans. British Myc. Soc. **9** : 284–286. 1926.

HOST INDEX

Bothriochloa insculpta A. Camus
    Sphacelotheca Amphilophis Sydow.

Bothriochloa pertusa. A. Camus.
    Sphacelotheca tenuis (H. & P. Syd.) Zundel

Bothriochloa sp.
    Sphacelotheca Doidgeae Zundel

Briza maxima L.
    Tilletia Viennotii Sydow

Bromus unioloides H. B. K.
    Ustilago bromivora (Tul.) Fisch.

Carex ethiopica Schkuhr.
    Farysia olivacea (D.C.) H. & P. Syd.

Carex phacota Spreng.
    Farysia olivacea (D.C.) H. & P. Syd.

Carex sp.
    Cintractia leucoderma (Berk.) P. Henn. (Appendix A)

Cenchrus ciliaris L.
    Sorosporium cenchri (Bref.) Zundel
    Ustilago Penniseti Rabh. (Appendix A)

Chloris abyssinica Hochst.
    Tolyposporium Chloridis P. Henn. (Appendix B)

Chloris gayana Kunth.
    Tolyposporium chloridis P. Henn. (Appendix B.)

Cissus sp. (Vitis sp.)
    Entyloma cissigenum P. Henn. (Appendix A.)

Cymbopogon elegans Spreng.
    Sorosporium Holstii P. Henn.

Cymbopogon excavatus Stapf.
    Sphacelotheca natalensis Zundel

Cymbopogon plurinodis Stapf
    Sorosporium pretoriaense Zundel
    Sphacelotheca concentrica Zundel
    Sphacelotheca Moggii Zundel

Cymbopogon Schoenanthus Spreng.
    Sphacelotheca Andropogonis (Opiz.) Bubak
    Sphacelotheca Milbraedii (H. & P. Syd.) Zundel

Cymbopogon sp.

Sphacelotheca Zilligii Zundel

Dichanthium sp.

Digitaria ternata Stapf

Ustilago Rabenhorstiana Kuhn

Digitaria sp.

Ustilago Rabenhorstiana Kuhn

Echinochloa Crus-galli Beauv.

Sphacelotheca Panici-miliacei (Pers.) Bubak (Appendix A.

Ustilago trichophora (Link.) Kunze

Echinochloa Holubii Stapf

Ustilago Crus-galli. Tracy and Earle.

Ustilago Holubii Syd.

Echinochloa sp.

Sorosporium cryptum McAlp.

Ehrarta sp.

Ustilago Sladenii Pole-Evans (Appendix A.)

Elionurus argenteus Nees

Ustilago Elionuri P. Henn. and Pole-Evans

Enneapogon brachystachyus Stapf

Sphacelotheca modesta (Syd.) Zundel

Enneapogon sp.

Sphacelotheca Pappophori (Pat.) Zundel

Eragrostis aspera Nees

Tilletia transvaalensis Zundel

Erianthus Saccharoides Michx.

Ustilago scitaminea H. Sydow

Eriospermum latifolium.

Tuburcinia Eriospermii H. Syd. (Appendix A.)

Eucomis punctata L'Herit.

Ustilago Vaillanti Tul.

Fingerhuthia africana Lehm.

Ustilago Fingerhuthiae Syd.

Heteropogon contortus (L.) Roem. et Schultz.

Sphacelotheca monilifera (Ell. et Ew.) Clint.

Sphacelotheca columellifera (Tue.) Ciferri

Heteropogon hirtus Pers. (see H. contortus R. & S.)

Hordeum vulgare L.

Ustilago Hordei (Pers.) Lagerh.

Ustilago nuda (Jens.) Kell. et Sw. (Appendix A.)

Hyparrhenia aucta (Stapf) Stent

Sorosporium proliferatum Zundel

Hyparrhenia cymbaria Stapf

Sphacelotheca Ritchiei Zundel

Hyparrhenia hirta Stapf

Ustilago puellaris Syd.

Hyparrhenia rufa Stapf

Sorosporium Zundelianum Ciferri

Hyparrhenia Ruprechtii Fourn.

Sorosporium Everhartii Ell. and Gall.

Sphacelotheca Andropogonis (Opiz.) Bubak

Sphacelotheca Evansii Zundel

Sphacelotheca Ruprechtii Syd.

Hyparrhenia Tamba Anderss.

Sorosporium austro-africanum Zundel

Sorosporium Clintonii Zundel

Sorosporium Maraguenense P. Henn.

Sorosporium Tembuti P. Henn and Pole-Evans

Hyparrhenia sp.

Sorosporium Healdii Zundel

Sphacelotheca tenuis (H. & P. Syd.) Zundel

Imperata arundinacea Cyrilli

Ustilago scitaminea H. Syd.

Juncus capensis Thunb.

Cintractia capensis (Reess) Ciferri (Appendix A.)

Cintractia piluliformis (Berk.) P. Henn. (Appendix A.)

Juncus lomatophyllus Spreng.

Cintractia capensis (Reess) Ciferri (Appendix A.)

Juncus sp.

Cintractia piluliformis (Berk.) Ciferri (Appendix A.)

Ustilago piluliformis (Appendix A.)

Melinis tenuinervis Stapf

Cintractia Melinis Zundel

Oleandra articulata Swartz

Entyloma Oleandrae. P. Henn. (Appendix A.)

Ornithogalum lacteum Jacq.

Ustilago Peglerae Syd. & Butler

Ornithoglossum glaucum Salisb.

Urocystis Ornithoglossi (Syd.) Zundel

Panicum Carthaginense Sw.

Sphacelotheca Panici-miliacei (Pers.) Bubak (Appendix A.)

Panicum Crus-galli Linn. (see Echinochloa Crus-galli Beauv.)

Panicum helopus Trin. (see Urochloa helopus Stapf)

Panicum laevifolium Hack.

Sorosporium afrum Syd.

Sorosporium harrismithense Zundel

Tilletia heterospora (P. Henn.) Zundel

Panicum longijubatum Stapf.

Sorosporium versatilis (Syd.) Zundel

Panicum maximum Jacq.

Sorosporium Panici McKinnon

Tilletia heterospora (P. Henn.) Zundel

Panicum miliaceum Linn.

Sphacelotheca Panici-miliacei (Pers.) Bubak (Appendix A.)

Panicum proliferum Lam. var. *paludosum* Stapf. (see P. longijubatum Stapf

Panicum trichopus Hochst.

Sorosporium africanum (Syd.) (Appendix B.)

Panicum sp.

Tilletia heterospora (P. Henn.) Zundel

Ustilago ugandensis P. Henn. (Appendix A.)

Pappophorum scabrum Kunth

Sphacelotheca Pappophori (Pat.) Zundel

Penicillaria spicata Willd.

Tolyposporium Penicillariae Bref. (Appendix A.)

Pennisetum cenchroides Rich. (see Cenchrus ciliaris L.)

Pennisetum dichotomum Delile

Ustilago Penniseti Rabh. (Appendix A.)

Pennisetum fasciculatum Trin.

Ustilago Penniseti Rabh. (Appendix A.)

Pennisetum vulpinum Stapf. & Hubb.
    Ustilago Penniseti Rabh. (Appendix A.)

Physalis minima Linn.
    Entyloma australe Speg.

Physalis peruviana Linn.
    Entyloma australe Speg.

Polygonum lapathifolium Linn. var glabrum Burtt Davy.
    Melanopsichium austro-africanum (Speg.) G. Beck

Ranunculus biternatus Sm.
    Urocystis Anemones (Pers.) Schrot. (Appendix A.)

Rhyncospora aurea Vahl
    Cintractia leucoderma (Berk.) P. Henn. (Appendix A.)
    Cintractia usambarensis (P. Henn.) Ciferri (Appendix A.)

Rottboellia compressa L.
    Sphacelotheca densa (McAlp.) Ciferri
    Sphacelotheca flagellata (Syd.) Zundel

Rottboellia exaltata Linn.
    Sphacelotheca flagellata (Syd.) Zundel

Saccharum officinarum Linn.
    Ustilago scitaminea H. Syd.

Scilla Kraussii. Baker.
    Ustilago Vaillanti Tul.

Scilla sp.
    Ustilago Vaillanti Tul.

Setaria aurea A. Br. (see S. sphacelata Stapf & Hubb.)

Setaria italica (L.) Beauv.
    Ustilago Crameri Korn.

Setaria nigrirostris Dur. and Schinz.
    Ustilago Evansii P. Henn.

Setaria perennis Hack.
    Sorosporium Setariae McAlp.

Setaria sphacelata Stapf. & Hubb.
    Tolyposporium setariicolum H. & P. Syd. (Appendix A.)

Setaria sp.
    Ustilago Evansii P. Henn.

Sorghum caffrorum Beauv. (see S. vulgare Pers. var caffrorum)

Sorghum halepense Pers.

Sorosporium Reilianum (Kuhn) McAlp.
Sorosporium Simii P. Henn. and Pole-Evans.
Sphacelotheca cruenta (Kuhn) Potter

Sorghum versicolor Anders.
Sphacelotheca transvaalensis Zundel

Sorghum vulgare Pers.
Sphacelotheca cruenta (Kuhn) Potter

Sorghum vulgare Pers. var. caffrorum (Thum.) Hubb. and Rehder
Sorosporium filiferum (W. Busse) Zundel
Sorosporium Reilianum (Kuhn) McAlp.
Sphacelotheca Holci H. S. Jackson
Sphacelotheca Sorghi (Link.) Clint.

Sorghum sp.
Sorosporium Reilianum (Kuhn) McAlp.
Sphacelotheca cruenta (Kuhn) Potter
Tolyposporium Volkensii P. Henn. (Appendix A.)

Sporobolus indicus R. Br.
Ustilago Schlechteri P. Henn.

Stenotaphrum glabrum (see St. secundatum (Walt.) Kunze

Stenotaphrum secundatum (Walt.) Kunze
Ustilago affinis Ell. and Ew.

Themeda Forskalii Hack. (see Th. triandra Forsk.)

Themeda triandra Forsk.
Sorosporium Holstii P. Henn.
Sphacelotheca Vryburgii Zundel

Trachypogon plumosus Nees
Ustilago Trachypogonis Zundel

Tristachya Rehmanni Hack.
Tolyposporium trystachydis (Syd.) Zundel

Triticum dicoccum Schrank
Urocystis Tritici Koern

Triticum durum Desf.
Urocystis Tritici Koern

Triticum turgidum Linn.
Urocystis Tritici Koern

Triticum vulgare Vill.
Tilletia foetans (B. & C.) Trel.

Tilletia Tritici (Bjerk.) Wint.
Urocystis Tritici Koern
Ustilago Tritici (Pers.) Rostr.

Urochloa helopus Stapf
Sorosporium verecundum (Syd.) Zundel
Sphacelotheca pretoriense (Pole-Evans) Zundel

Welwitschia mirabilis Hook.
Ustilago Welwitschiae Bres. (Appendix B.)

Zea Mays Linn.
Sorosporium Reilianum (Kuhn) McAlp.
Ustilago Zeae (Beckm.) Unger

Zinnia pauciflora Linn.
Entyloma Zinniae Syd.

INDEX OF GENERA, SPECIES AND SYNONYMS.

SOME SOUTH AFRICAN FUSARIA.

By E. M. Doidge.

The revised list of plant diseases known to occur in South Africa, which was published in 1931 (8), records a large number of *Fusarium* spp. found in diseased tissues, particularly in connection with wilts and foot rots. That little is known of the rôle of these organisms in plant disease in this country, is indicated by the fact that comparatively few South African records are to be found in the recent book "Die Fusarien," by Wollenweber and Reinking (61); therefore as a first step in the study of wilts and foot rots and the decay of storage organs, it was considered desirable, that as many strains as possible of the Fusaria associated with plant disease, should be studied and classified. The present account can only be regarded as a preliminary study of the genus *Fusarium* in South Africa; the work is far from complete, and records are lacking of a number of forms said by Wollenweber (61) to be prevalent in all warm countries; species of *Fusarium* are probably responsible for a number of wilt diseases which have not yet been investigated. A general survey of this kind, however, should be a useful basis for more detailed study, especially of the species causing vascular wilts of specific plants.

A large number of strains ($\pm$ 100) was isolated while making a study of dry root rot of citrus trees, which is one of the most serious causes of loss in orange orchards. It was found that a large percentage of the fungi isolated from decaying citrus roots belonged to the genus *Fusarium*; these organisms were also found in roots apparently healthy and in the soil. Inoculation experiments have, so far, given only negative results, and it is not known what part the fungi play in the decay of the roots.

A further 300 strains were isolated while making a survey of the fungi found in citrus fruits decaying in storage. Apart from the citrus investigations, no systematic collections have been made. Many strains were isolated from plants sent for examination, or were obtained in the course of investigation of wilt diseases of tobacco, tomato, aster, cucurbits and other plants, by officers of the Division of Plant Industry. About 850 strains were studied in all, but a small percentage could not be brought into good sporulating condition and was discarded unidentified; these strains were chiefly Fusaria of the "*elegans*" section.

The method employed was as follows: Small portions of the affected tissues were planted in prune agar plates, and when sufficient growth had taken place, transfers were made to plain agar plates from which hyphal tip isolations were made (6), or single spore cultures were obtained by the dilution method. The culture media used for detailed observations and the methods adopted, were those recommended in "Fundamentals for taxonomic studies of Fusarium" (62); the synthetic medium adopted as a standard medium by Brown (7) with the addition of starch, was also used, as it proved a useful medium for the production of conidia; this medium was also largely used for stock cultures. In computing percentages of conidia with 0–3–5 or more septations, some 200 conidia were counted, and a large number were measured to get extreme and average measurements. (Measurements are given in microns unless otherwise stated.) Ridgways' colour standards and nomenclature (40) were used for recording the colours of conidia, mycelium and stroma of the various strains in culture on standard media. Representative conidia of each species, variety and form were drawn to scale with the aid of the camera lucida, the magnification being 1 : 800.

The general descriptions of species and varieties were adapted from those found in the monographs of Wollenweber and Reinking (59, 61), where full synonymy and bibliography may be found, the more detailed descriptions of conidia and cultural characters being derived from a study in culture of the South African strains isolated. Dried cultures of representative strains have been deposited for reference in the Cryptogamic section of the South African National Herbarium, these being indicated in the text by M.H. (mycological herbarium) numbers.

I am greatly indebted to Dr. Wollenweber for his advice and co-operation. He very kindly examined and identified some 50 strains in culture, and his annotations on the identifications were of great assistance, especially in the earlier part of the work. I am also indebted to him for perusing and criticising the manuscript.

I also wish to acknowledge the very considerable assistance of Mr. L. J. Kresfelder, who made a number of the original isolations, and was responsible for the major part of the laborious work of conidial computations and measurements. To Dr. V. A. Wager, I am indebted for a large number of cultures from wilting tomato and aster plants and from a number of other hosts. His isolations and collections are distinguished by his name in brackets after the record. I am also indebted to several other officers of the Division of Plant Industry for cultures and material.

FUSARIUM (Link).

Link H.F. in Mag. Ges. nat. Fr. 3 : 10, 1809 ; Spec. Plant. 2 : 105, 1825. Saccardo, Michelia 2 : 35, 1880 ; Syll. Fung. 4 : 694, 1886. Appel and Wollenweber in Arb. Biol. Anst. f. Land.-u. Forstw. Berlin–Dahlem 8 : 60, 1910. Wollenweber and Reinking, Die Fusarien p. 9, 1935.

Syn. *Fusisporium* Link pr.p. in Mag. Ges. nat. Fr. 3 : 19, 1809 ; Spec. Plant. 1 : 30, 1824.
Fusidium Link pr. p. in Mag. Ges. nat. Fr. 3 : 10, 1809 ; Spec. Plant. 2 : 96, 1825.
Atractium Link pr. p. in Mag. Ges. nat. Fr. 3 : 10, 1809.
Fusoma Corda, Icon. Fung. 1 : 7, 1837.
Selenosporium Corda Icon. Fung. 1 : 7, 1837.
Pionnotes Fries, Summa. Veg. Scand. p. 481, 1849.
Microcera Desm. pr. p. in Ann. Sci. nat. 3, sér. 10 : 359, 1848.
Discofusarium Petch in Trans. Brit. Myc. Soc. 7 : 164, 1922.
Pseudomicrocera Petch in Trans. Brit. Muc. Soc. 7 : 164, 1922.
Discocolla Prill. et Del. in Bull. Soc. Myc. France 10 : 86, 1894.

Conidia scattered in the mycelium, in false heads forming large or small balls, in flat or raised mucilaginous layers (pionnotes), on a smooth or wrinkled thallus or direct on the substratum, or in masses on a tubercularia-like plectenchymatous to sclerotial stroma of limited extent (sporodochia) ; pale or brightly coloured (orange, salmon, ochre) in mass. Conidia often of two kinds ; microconidia which are usually 1-celled and scattered ; macroconidia which are usually 3- or more septate, fusiform to falcate, dorsiventral, curved in various ways or almost straight, and often with a pedicellate base.

Conidiophores simple to compoundly sub-verticillate ; conidia produced successively at the tips of the septate main conidiophore, or at the tips of its irregular or whorled lateral branches, sometimes united in chains. Occasionally they are formed (yeast-like) directly on the mother conidium or on short sterigma-like branches arising from it.

Chlamydospores usually present, globose, ovoid or pear-shaped, 1–2-celled or in chains or clusters, terminal or intercalary, brownish in colour or becoming tinged with the colour of the stroma.

Sclerotia spherical, solid, occurring singly, or in groups, or absent. Sclerotial stromata occur in many groups ; they are erumpent, hemispherical, smooth or rough and cauliflower-like ; or erect, stilboid, sometimes with antler-like branching, sessile or stalked ; they serve as a stroma for the sporodochia or remain sterile.

Hyphae septate, sparse or abundant, branched in various ways, epi- or endo-phytic, free or forming a mycelium which may be loosely interwoven, or form a close, coremium-like to plectenchymatous or sclerotial mass. The mycelium is partly submerged and partly superficial, pale or brightly coloured (red, yellow, brown, green, blue). Aerial mycelium mould-like; mycelium in substratum gelatinous, leathery, plectenchymatous, often with patches of sclerotial thickening.

A number of species of *Fusarium* are the conidial forms of Ascomycetes of the genera *Nectria*, *Calonectria*, *Gibberella* and *Hypomyces*.

The genus has been divided by Wollenweber (61) into sixteen sections and sub-sections.

Key to the Sections and Sub-sections.

A.—Microconidia normally present, usually 1-celled, ovoid, fusoid, reniform or pyriform :—
- B.—Microconidia more or less pyriform.................. *Sporotrichiella.*
- BB.—Microconidia not pyriform :
  - C.—Chlamydospores wanting :
    - D.—Microconidia in chains :
      - E.—Macroconidia thin-walled; colour and form of conidia and stromalike *Lateritium*........... *Liseola.*
      - EE.—Macroconidia comparatively thick-walled; colour, form of conidia, stroma and sclerotia like *Discolor*.......................... *Spicarioides.*
    - DD.—Microconidia not in chains in *F. neoceras*, and *F. moniliforme* v. *subglutinans* (*Liseola*), and *F. lateritium* vars. *minus* and *uncinatum* (*Lateritium*):
  - CC.—Terminal and intercalary chlamydospores present :
    - D.—Conidia with thin walls and delicate, rather inconspicuous septa, tapering or constricted towards the apex, pedicellate at the base, in mass brownish-white, pink, salmon-orange or sometimes quite pale *Elegans.*
    - DD.—Conidia with comparatively thick walls and distinct septations, sub-truncate, rounded or briefly rostrate, somewhat curved at the apex, more or less pedicellate at the base; in mass brownish-white, cream, golden yellow or often taking up the blue or green colour of the stroma..................... *Martiella.*

AA.—Microconidia usually wanting, or 1–3- or more -septate, reniform, comma-shaped, fusoid or falcate :
- B.—Macroconidia apedicellate, usually apiculate :
  - C.—Pionnotes typically present. Comparatively slow-growing fungi, with thin-walled, indistinctly septate conidia :
    - D.—Stroma effuse, immersed, or matted and coremium-like, but not stilboid. Conidia subulate.......... *Eupionnotes.*
    - DD.—Stroma cone-shaped to club-shaped, hard and horny when dry; or sessile, flat, loose, floccose. Conidia subulate, like those of the *Roseum* section :
      - E.—Entomogenous fungi (on scale insects)...... *Pseudomicrocera.*
      - EE.—Mycogenous fungi (on old Sphaeriaceae)...... *Submicrocera.*
  - CC.—Pionnotes scanty or wanting, seldom abundant. Comparatively quick-growing fungi..................... *Arachnites.*

BB.—Macroconidia more or less pedicellate :

C.—Terminal chlamydospores absent :

D.—Intercalary chlamydospores wanting ; conidia in sporodochia and pionnotes salmon or orange ; stroma effuse or erumpent, stilboid :

E.—Conidia thick-walled, sub-cylindrical, curved, abruptly constricted, curved and rostrate at the apex (as in *Martiella*). Comparatively slow-growing, entomogenous (on scale insects) and mycogenous fungi.................... *Macroconia.*

EE.—Conidia with thin walls and delicate, rather indistinct septa. Stroma often sclerotially erumpent, dark blue or pale :

F.—Macroconidia subcylindrical and equilaterally curved in the middle ; abruptly constricted, recurved and rostrate at the apex. Mycelium white to pink. Stroma pale, sometimes violet, olivaceous, green. Form of conidia, colour, stroma and sclerotia like *Elegans*.............................. *Lateritium.*

FF.—Macroconidia subcylindrical in the middle, curvature often somewhat inequilateral, long, subulate, falcate, tapering to both ends. Mycelium and stroma variable in colour, pink, purple, yellow or pale. Conidia mostly orange-red................. *Roseum.*

DD.—Intercalary chlamydospores present.

E.—Sporodochia usually wanting. Free conidia scattered in floccose mycelium, fusoid ; macroconidia either fusiform-lanceolate, tapering to both ends and not pedicellate ; or falcate and pedicellate. Colour pale, varying between *Gibbosum* and *Roseum*...................... *Arthrosporiella.*

EE.—Sporodochia present. Sclerotia dark blue, brownish-white or wanting.

F.—Macroconidia thin-walled, fusiform-falcate with parabolic or hyperbolic curvature, inequilateral ; apical cell prolonged, filiform to flagelliform ; base definitely pedicellate ; conidia in mass pale or pink to salmon ochre ; stroma brown, seldom carmine or yellow..................... *Gibbosum.*

CC.—Intercalary and sometimes terminal chlamydospores present :

FF.—Macroconidia with comparatively thick walls and septa, fusiform-falcate, tapering to both ends, inequilaterally curved ; apical cell sometimes constricted, almost rostrate, sometimes truncate or elongated; base pedicellate ; conidia in mass ochre, pink, salmon or orange. Stroma pale, pink, carmine, purple, yellow, brown, blue ; rarely pale and concolorous.

Sclerotia dark blue, brown, ochre or wanting. Mycelium white, pink or yellowish, sometimes flecked with blue.... *Discolor.*

CCC.—Terminal chlamydospores present, intercalary wanting. Stroma effuse, floccose to gelatinous; the long mycelial strands sometimes forming a coremium-like body, but not producing tubercularia-like sporodochia. Conidia scattered, in false heads, not forming extensive mucilaginous layers; wedge-shaped, with thick walls and septa, cream-colour to brownish-white............... *Ventricosum.*

Section **MACROCONIA** Wr.

Wollenweber, Fusarium-Monographie pp. 274–281, 1931. Wollenweber and Reinking, Die Fusarien pp. 27–28, 1935.

Conidia produced in salmon-orange pionnotes and sporodochia: comparatively large, rather thick-walled, mostly 3–5–9-septate, sub-cylindrical, abruptly constricted or curved and rostrate at the apex, more or less pedicellate at the base. In some species a few small, scattered, 1–2-celled conidia occur. Chlamydospores absent or scarce. Sclerotia present or absent. The formation of the stroma is variable and depends on climatic conditions and on the mode of life of the fungus. It may be limited in extent or effuse, smooth or wrinkled, or, when aerial mycelium is abundant, filamentous and loosely interwoven. Later it may be compact and assume various forms; occasionally also it may be delicate and evanescent or consist of hyphae penetrating the substratum, and then the conidia appear to be borne directly on the surface of the substratum.

Entomogenous and mycogenous species parasitic on scale insects and on other fungi, chiefly dark-coloured *Sphaeriaceae.* The entomogenous species, *Fusarium coccophilum*, is described by Wollenweber and Reinking (61) as the conidial form of *Nectria coccophila* (Tul.) Wr.

Fusarium coccophilum (Desm.) Wr. et Rkg.

Wollenweber and Reinking, Die Fusarien pp. 34–36, 1935. Wollenweber, Fus. aut. del. 344–348 351, 614, 861–868, 1124–1126.

Syn. *Microcera coccophila* Desm.; *Tubercularia coccophila* Bon.;
Microcera aurantiicola Petch; *M. coccidophthora* Petch;
Fusarium (*Fusisporium*) *coccinellum* (Kalch.) Thuem.;
Atractium flammeum Berk. et Rav.; *Stilbum flammeum* Tul.;
Fusarium baccharidicola P. Henn.; *F. callosporum* Pat.;
F. cataleptum Cke. et Harkn.; *F. nectriae-turraeae* P. Henn.;
Pionnotes pseudonectria Speg.; *Microcera pluriseptata* Cke. et Mass.

Stroma sometimes minute, evanescent, sometimes more or less plectenchymatous, hard when dry and becoming cartilaginous, or composed of loosely interwoven hyphae; occasionally wanting.

Conidia either abstricted from hyphae lying on the substratum, or forming an extensive pionnotal layer, or produced in sporodochia. The latter are composed of densely fasciculate conidiophores arising from a plectenchymatous base, or from a stilboid body composed of ascending hyphae united into a coremium. Sporodochia flattened-globose, conical, clavate or cylindrical, 0·5–2·5 × 0·25–0·6 mm., peach red to scarlet, fading to flesh ochre and rufous with age, surrounded at the base by a thin plectenchymatous sheath, which is continuous below and terminates above in irregular points. Conidiophores branching irregularly, seldom with opposite branches in pairs. (Plates II and IV.)

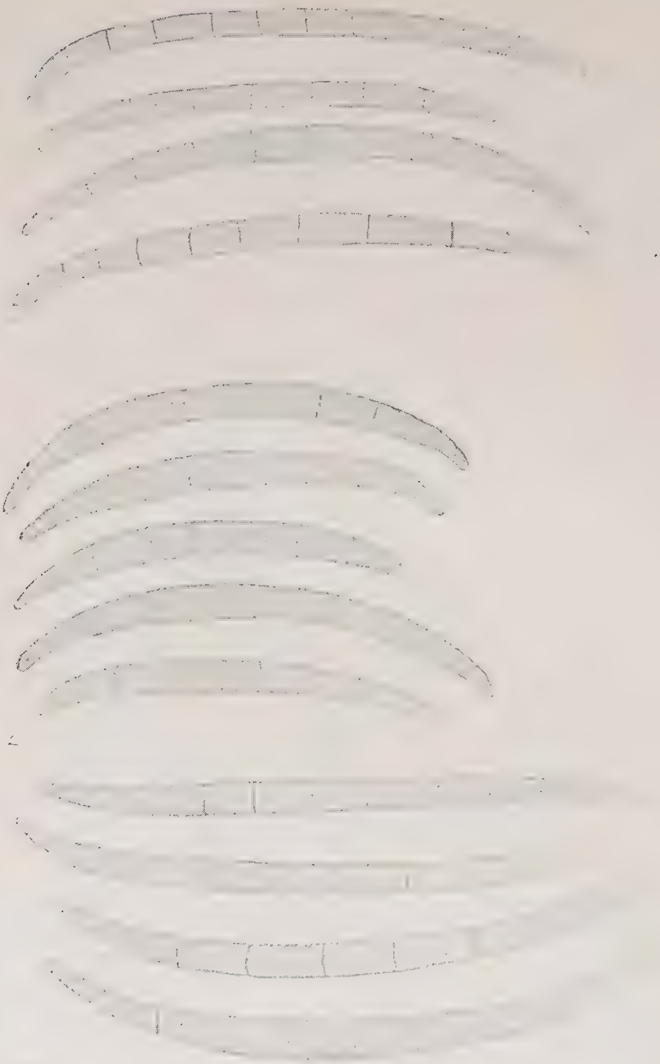

Fig. 1.

Fusarium coccophilum (Desm.) Wr. et Rkg.; macroconidia from (*a*) red scale on *Citrus* (M.H. 12174,) (*b*) pernicious scale on *Pyrus* (M.H. 21932), and (*c*) pionnotes of culture on oat agar, 14 days old.

Conidia thick-walled, sub-cylindrical to falcate, tapering to both ends; apical cell somewhat abruptly bent and constricted; base conical to subpedicellate. Conidia 5–7- or 7–9-septate, less frequently 3–4- and 10–12-septate; in mass salmon-orange to orange-scarlet; occasionally the cross walls are not easily perceptible.

3-septate..................	35–78 × 4–5.
5-septate..................	50–95 × 4·5–7.
7-septate..................	50–112 × 4·5–8.
9-septate..................	60–117·5 × 5–8.
11–12-septate...............	98–142 × 5–8.

Chlamydospores and sclerotia lacking.

Fusarium coccophilum has been shown by Wollenweber and Reinking (61) to be the conidial stage of *Nectria coccophila*. The ascus form has not yet been observed in South Africa, although the conidial stage is extremely common. A description of *Nectria coccophila* follows :—

Nectria coccophila (Tul.) Wr. et Rkg.

Wollenweber and Reinking, Die Fusarien pp. 34–36, 1935. Wollenweber, Fus. aut. del. 679–682.
Syn. *Sphaerostilbe coccophila* Tul.

Nectria aurantiicola B. et Br. ; *Sphaerostilbe aurantiicola* (B. et Br.) Petch.
Corallomyces aurantiicola (Berk. et Br.) Höhn.
Nectria coccidophthora Zimm. ; *Sphaerostilbe coccidophthora* (Zimm.) Petch.
Nectria coccidophthora Zimm. v. *aurantiicola* (Berk. et Br.) Rehm.
N. Balansae Speg. ; *N. congoensis* Syd.
N. laeticolor Berk. et Curt. ; *Sphaerostilbe flammea* Tyl.
N. Aglaothele Berk. et Curt. ; *N. colletiae* Rehm ; *N. muscivora* Berk.
N. Passeriniana Cke. ; *Nectria coccicida* Speg. (in MS.).
N. subcoccinea Sacc. et Ell. ; *N. subfurfuracea* P. Henn. et E. Nym.
N. Turraeae P. Henn.

Perithecia scattered or in groups, arising from a plectenchymatous or floccose stroma, 0·2–0·4 mm. diam. (average 0·28 × 0·25 mm.), orange red to dark red, darker at the ostiole, smooth or somewhat rough, almost spherical or conical, cupulate or laterally depressed. Ostiole papillate or not prominent. Asci cylindrical to club-shaped, with or without pedicel, 8-, seldom 4-spored, 70–130 × 6–10, usually monostichous. Paraphyses linear, delicate, evanescent. Spores oval to ellipsoid, at first hyaline, then yellowish pink ; later thick-walled and finely verrucose, brown, 1-septate, 9–26 × 4–11, mostly 12–18 × 6–8 ; the larger spores from 4-celled asci.

The *Fusarium* stage has been found on the following hosts in South Africa :

Hab. *Aspidiotus furcillae* Brain on bark of *Acacia horrida*, Somerset East, in silvis, 1876, leg. MacOwan (de Thuemen Myc. Universalis 782) M.H. 21956 ; pr. pedem montium Boschberg, prope Somerset East, Nov., 1875, Fungi MacOwaniana 1059, M.H. 20913.

Aspidiotus perniciosus Comst. (pernicious scale), on twigs of *Pyrus communis*, Chasedene, Maritzburg, Natal (van der Vyver), M.H. 21932.

Aspidiotus rapax Comst. (greedy scale) on twigs of *Ribes* sp., Haenertsburg, N. Transvaal, July 1911 (Doidge) M.H. 1684.

Chrysomphalus aurantii Mask. (red scale) on twigs and leaves of *Citrus* spp., Maritzburg, Natal, May, 1919 (Kelly) M.H. 12174 ; without locality, April 1929, M.H. 25438 ; Duivelskloof, N. Transvaal, August 1911 (Doidge) M.H. 1845 ; Elim, N. Transvaal, January 1925 (Doidge) M.H. 20344 ; Bredasdorp, Cape (Turner) M.H. 20602 ; Alkmaar, E. Transvaal, June 1924 (Turner) M.H. 18191 ; Richmond, Natal, March 1922, (Tedder) M.H. 15479 ; Mt. Silinda, S. Rhodesia, August 1931 (Lounsbury) M.H. 25973 ; Maritzburg, May 1932 (van der Vyver) M.H. 26322 ; Politsi, N. Transvaal, Sept. 1934 (Wager) M.H. 27689 ; Elim, April 1935 (Nyenhuis) M.H. 27561 ; Forest Hill, Tzaneen, Aug. 1932 (Turner) M.H. 26568.

Chrysomphalus aurantii Mask. (red scale) on twigs of *Rosa* sp., Ravenshill, N. Transvaal (Eland) M.H. 25932 ; Maritzburg, Nov. 1933 (Fouché) M.H. 27282.

Chionaspis sp., Victoria Falls, Rhodesia (Lounsbury) Aug. 1931, M.H. 25974.

Lepidosaphes Gloveri (mussel scale) on twigs of *Citrus* spp., Chase Valley, nr. Maritzburg, Feb. 1932 (van der Plank) ; Port St. Johns, Pondoland (Fraser) M.H. 26323.

Scale undet. on *Plectronia* sp., Cape Province, Oct. 1906 (Lounsbury) M.H. 193.

This species occurs on scale insects in tropical and subtropical regions in all parts of the world. The South African fungus was first collected by MacOwan in 1876 on *Aspidiotus furcillae* on *Acacia*, and was described as *Fusisporium coccinellum* Kalch., and then as *Fusarium coccinellum* (Kalch.) Thuemen in Fungi austro-africani, Flora 1876, p. 426 (Wollenweber Fus. aut. del. 344 and 861). It was also collected by Medley Wood (Wood No. 157)

on a scale insect on an unknown tree, Port Natal, and was identified as *Fusarium bacchari-dicola* P. Henn. (Wollenweber Fus. aut del. 865), which is now regarded as a synonym for *F. coccophilum*.

Fusarium coccophilum occurs on a number of different scale insects in the more humid, sub-tropical areas; it is very variable in the size and septation of the conidia. Fifteen collections were examined in detail; in seven of these 7–9-septate conidia predominated, in five (including MacOwan's collection) 5–7-septate conidia were most frequent, and in two of the collections most of the conidia were 3–5-septate. In culture there is an even wider range of size and septation than in conidia developing on the natural host.

For a full discussion of the nomenclature and synonymy of *Fusarium coccophilum*, see Wollenweber and Reinking (61) and Petch (33, 34).

Growth on Standard Media.

Oat agar: Growth slow, barely covering the surface of the slant in 7 days; growth in substratum colourless at first, but after 4 weeks tinged vinaceous russet, especially near base of slant. Pionnotes formed on older part of growth, and were well developed after 14 days; they were at first flesh colour, then salmon colour.

Hard potato agar: Growth slow; no aerial mycelium, growth in substratum colourless. Sporodochia formed in small groups, bitter-sweet-pink.

Standard synthetic agar plus starch: Growth slow, and mycelium almost covered with pionnotes which were well developed after 4 weeks; pionnotes at first salmon orange then bitter-sweet orange. After 8 weeks a group of sporodochia had developed at the base of the slant.

Potato agar plus 5 *per cent. dextrose:* Growth very slow, and conidia very freely produced. Pionnotes bitter-sweet orange to flame scarlet; mycelium fine, white, only visible as a ringe round the pionnotes.

Potato plug: Growth very slow, and consisting of a salmon-colour cushion-like stroma about 10 mm. diameter, with a very little fine, white mycelium in places on the surface. In four weeks the stroma became very much folded and wrinkled, and the colour faded to light pinkish cinnamon.

Melilotus stem: Growth very slow, forming a small cushion 5–10 mm. in diameter, bitter-sweet pink underneath, overlaid with a little fine, white mycelium.

Bean pod: Growth resembling that on potato, but less vigorous, and aerial mycelium very scanty.

Rice: Growth very slow, and penetrating very little into the medium; growth on substratum bitter-sweet pink. After 4 weeks the rice grains were covered with conidia.

Measurements of Conidia.

A.—From sporodochia on red scale and other scale insects; summary of measurements from 15 collections recorded above. Conidia in some collections chiefly 5–7-septate, and in others 7–9-septate; in two cases the majority were 3–5-septate.

11-septate..................	100 × 6.
10-septate..................	95–107·5 × 5–6·25.
9-septate..................	60–117·5 × 5–6·25.
8-septate..................	60–112·5 × 5–6·5.
7-septate..................	57–107·5 × 4·5–6·5.
6-septate..................	60–92·5 × 4–6.
5-septate..................	50–95 × 4·5–6.
4-septate..................	52·5–82·5 × 4·5–5.
3-septate..................	47·5–77·5 × 4·5–5·5.

B.—From sporodochia on pernicious scale (M.H. 21932); conidia in this collection were mostly 5–7-septate, more rarely 9-septate, a few 3-septate. Exact computations were not made.

9-septate	72·5–82·5 × 5–6·25.
7-septate	57·5–80 × 5–6·25.
5-septate	55–70 × 5–6.
3-septate	47·5–52·5 × 5–6.

C.—From culture derived from conidia of sporodochia on pernicious scale (M.H. 21932). Standard synthetic agar plus starch, culture 2 weeks old, conidia from pionnotes :—

11-septate	1 per cent	100–110 × 5–5·5.
10-septate	2 ,,	100–110 × 5–5·5.
9-septate	76 ,,	90–110 × 4·5–5·5.
8-septate	9 ,,	90–100 × 5–5·5.
7-septate	12 ,,	85–100 × 5–6.

Oat agar, culture 2 weeks old, conidia from pionnotes :—

12-septate	2 per cent	100–105 × 5.
11-septate	4 ,,	97·5 110 × 5.
10-septate	10 ,,	95–102·5 × 5–5·3.
9-septate	35 ,,	90–112·5 × 5.
8-septate	27 ,,	80–105 × 5.
7-septate	10 ,,	77·5–105·5 × 5–5·3.
6-septate	7 ,,	77·5–85 × 5.
5-septate	5 ,,	65–87·5 × 5.
4-septate	Rare	65 × 5.

Hard potato agar, culture 2 weeks old, conidia from pionnotes :—

11-septate	Rare	105 × 5·3.
10-septate	,,	115 × 5·3.
9-septate	5 per cent	92·5–105 × 5·3.
8-septate	18 ,,	82·5–102·5 × 5.
7-septate	37 ,,	75–100 × 5.
6-septate	22 ,,	75–80 × 5.
5-septate	18 ,,	50–85 × 5.
4-septate	Rare	60 × 5.

Section **SPICARIOIDES.**

Wollenweber, Sherbakoff, Reinking, Johann and Bailey, in Jour. Agric. Res. 30 : 841, 1925. Reinking and Wollenweber, Phil. Jour. Sci. 32 : 169, 1927. Wollenweber, Fusarium-Monographie 311, 1931. Wollenweber and Reinking, Die Fusarien, 36, 1935.

Microconidia delicate, ovoid, developing in chains and false heads, and later scattered in the mycelium. Macroconidia pluriseptate, thick-walled, cylindrical, moderately curved, constricted and rostrate at the apex ; base pedicellate ; borne in sporodochia and pionnotes, white to cream and ochre in mass. Stroma golden yellow to carmine red. Aerial mycelium white or tinged with the colour of the stroma. Sclerotia sometimes develope ; they are convex, rugulose or stilboid. Chlamydo-spores absent.

Fusarium decemcellulare Brick.

Brick, C. Jahresber. Ver. f. Angew. Bot. 6 : 227 (1908). Wollenweber, Fusarium-Monographie 311, 1931 ; Fus. aut. del. 353, 869, 870. Wollenweber and Reinking, Die Fusarien, 36–38, 1935.

Syn. *Spicaria colorans* van-Hall-de Jonge.

Fusarium spicariae-colorantis (van Hall-de Jonge) Sacc. et Trott.

Fusarium theobromae Lutz (nec App. et Strk.).

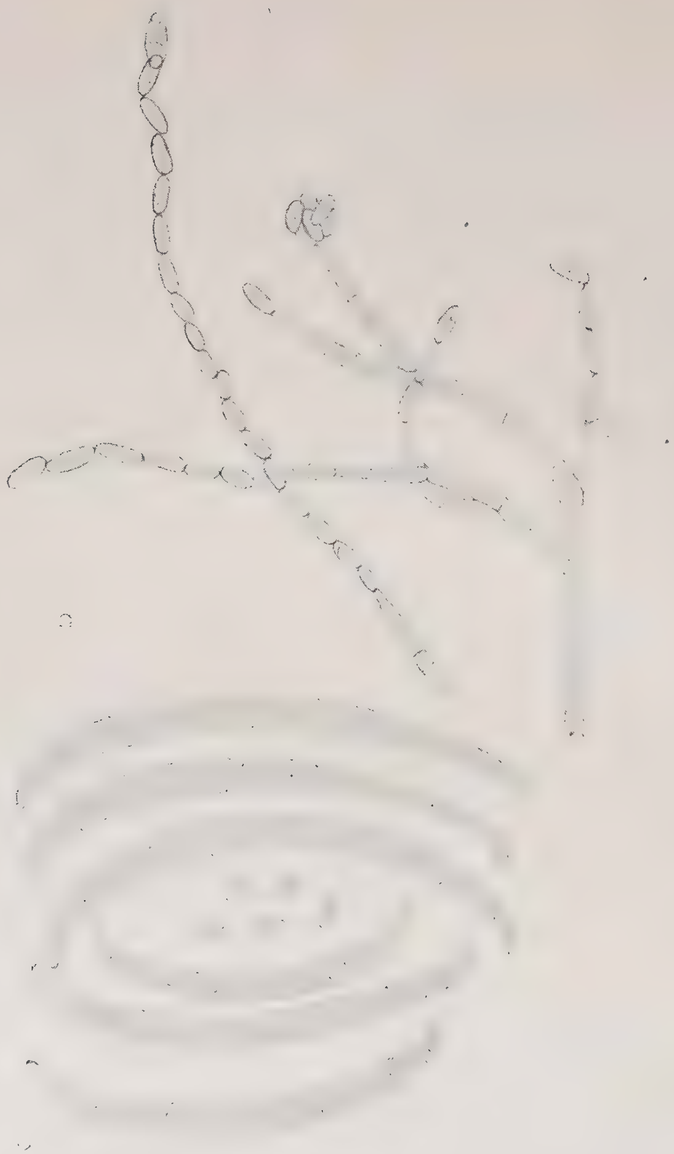

FIG. 2.

Fusarium decemcellulare Brick; (*a*) macroconida from sporodochia of culture on Melilotus stem, 4 weeks old; (*b*) microconidia from mycelium on plain agar, 10 days old.

Microconidia ovoid, 1–2-celled, in chains or false heads, produced on more or less branched conidiophores in the aerial mycelium; these form a powdery layer on the mycelium and are easily scattered. Macroconidia formed in sporodochia and pionnotes, which are at first white, then cream, brownish-white or ochraceous. Macroconidia large, cylindrical, somewhat curved especially near the ends, rostrate at the apex, pedicellate at the base, usually 5–9-, less frequently 3–4- or 10–12-septate.

0-septate..............	5-11 × 2 4·5, mostly.......	7 9 × 3–4.
1-septate..............	10–28 × 2–5, mostly.........	12–20 × 4–4·5.
3-septate..............	20–67 × 3·5–6, mostly......	25–42 × 4·5–5·5.
5-septate..............	42–72 × 4·5–8, mostly......	53–64 × 4·7–6·5.
7-septate..............	60–95 × 4·5–8, mostly......	58–78 × 5–7·7.
9-septate..............	68–114 × 4·5–8·5, mostly...	75–97 × 5–8.
11-septate..............	73–131 × 5–9, mostly..	80–111 × 5·3–7·5.
12–13-septate..............	90–130 × 6–9, rare.	

Stroma yellow or carmine red, covered with white to pink, aerial mycelium. Plectenchyma sclerotially erumpent, and forming sclerotial growths which are convex, rugulose or stilboid. From these the ascus form developes later. Chlamydospores absent.

Hab. *Epichloë Zahlbruckneriana* on *Sporobolus indicus*, associated with *Fusarium ciliatum* on the stroma, Acton Homes, nr. Bergville, Natal, March 1931 (L. A. Doidge).

Citrus sinensis Osbeck, from discoloured centre of Valencia orange from Zebediela, Transvaal, after 18 weeks in storage, 1934.

Fusarium decemcellulare is the conidial form of *Calonectria rigidiuscula;* the ascus stage has not yet been observed occurring naturally as a saprophyte in South Africa, but developed in cultures isolated from *Epichloë*, and sent to Dr. Wollenweber for identification. It may be characterised briefly as follows :—

Calonectria rigidiuscula (Berk. et Broome) Sacc.

Saccardo, Michelia 1 : 313 (1878). Wollenweber, Fusarium-Monographie 312–314, 1931 ; Fus. aut. del. 800–802. Wollenweber and Reinking, Die Fusarien, 37–38, 1934. (For complete bibliography and synonymy see last-named publications.)

Perithecia scattered or in groups, ovoid to subconical, cream-coloured, yellow-brown when dry, 0·27 to 0·6 × 0·18–0·4 mm. (average 0·36 × 0·28 mm.) ; asci 4-spored, seldom 2- or 8-spored. Spores fusoid, slightly curved, obtrusely conical at both ends, obliquely striate, brownish-white in mass, mostly 3-septate, seldom (up to 14 per cent.) 4 6-septate, very rarely 1–2- or 7-septate.

1-septate..........	13–18 × 6–9.........	Average 15 × 7·2.
3-septate..........	18–37 × 5–9.........	Mostly 19 × 5·5–7·5, the larger spores in 2-spored asci (31 × 7) and the smaller in 8-spored asci (15 26 × 5·5–7·5).
5-septate..........	23–38 × 7–9.........	Average 28 × 7·6.
7-septate..........	25–45 × 7–9.	

Stroma rough or flat, pale, golden yellow or brown, sometimes evanescent. Mycelium at first floccose, white or pink, then drying up and disappearing.

Hab.—In culture derived from mycelial mat surrounding stroma of *Epichloë Zahlbruckneriana* on *Sporobolus indicus*, cult. Wollenweber, M.H. 25897 B.

This species occurs on dry, decaying stems, fruits, etc., on various hosts (*Theobroma*, *Hibiscus*, *Melia*, *Anona*, *Ficus*) in tropical and sub-tropical regions of America, Asia and Africa.

Growth on Standard Media.

Oat agar : Mycelium at first woolly, short, white tinged rose pink, later becoming closely matted ; it may then become spinel red and Indian lake in colour. Growth in substratum amaranth purple. After 3–4 weeks, dense masses of buff yellow pionnotes, or a few separate sporodochia may be produced.

Hard potato agar : In cultures studied, growth on this medium was not vigorous, and consisted of a little white, tufted aerial mycelium on a colourless substratum. A few sporodochia developed after 8 weeks. Reinking and Wollenweber (39) however, record a more vigorous growth with a rather thin, matted mycelium in cultures 12 days old ; this was pomegranate purple, rose red and rose pink. Older cultures (45–90 days) had a more

matted mycelium with irregular, stromatic tufts, and the colour was pomegranate purple with a Bordeaux ring at the base. Sporodochia and pionnotes produced in large masses were warm buff and light orange yellow.

Standard synthetic agar plus starch: Aerial mycelium scanty; growth on substratum amaranth purple in the centre and olive ochre along the edges of the growth.

Potato agar plus 5 *per cent. dextrose:* Mycelium matted, pomegranate purple and olive ochre. Growth in substratum Bordeaux.

Potato plug: In cultures 14 days old, the plug was covered with tufted mycelium, which was white to rose colour. Spore masses were beginning to form. Groups of sporodochia, developing vigorously after 4 weeks, were light ochraceous buff; they often coalesced into large pionnotal masses. Individual sporodochia were sometimes columnar in shape.

Melilotus stem: After 14 days, stems were covered with a short, felt-like mycelium, which was white to tyrian pink, growth on the water at the base of the tube being amaranth purple. After 8 weeks, several groups of ochraceous buff sporodochia had developed.

Bean pod: Growth very similar to that on *Melilotus* stem, but spore masses produced less freely.

Rice: Growth Naples yellow to primuline yellow, in cultures 14 days old. In older cultures, the mycelium is more or less powdery, and yellow ochre to ochraceous orange in colour. Spore masses were sometimes produced.

Measurements of Conidia.

Potato plug, culture 4 weeks old, conidia from sporodochia:—

8-septate	Few	82·5 × 5.
7-septate	42 per cent	70–87·5 × 5–5·3.
6-septate	24 ,,	52·5–90 × 5–6·25.
5-septate	13 ,,	55–72·5 × 5–5·6.
4-septate	2 ,,	57·5 × 5.
0-septate	19 ,,	6–8 × 3–4·5.

Melilotus stem, culture 4 weeks old, conidia from sporodochia:—

9-septate	1 per cent	70–85 × 5·3.
8-septate	1 ,,	67·5–87·5 × 5–5·6.
7-septate	30 ,,	62·5–92·5 × 5–5·6.
6-septate	30 ,,	57·5–82·5 × 5–5·6.
5-septate	23 ,,	47·5–67·5 × 5–5·6.
4-septate	2 ,,	42·5–57·5 × 4·7–5.
3-septate	1 ,,	22·5–52·5 × 3·5–4·5.
0-septate	12 ,,	5–8 × 3·5–4·5.

Reinking and Wollenweber (39) give the following figures for the average measurements of conidia on several media:—

6-septate	17 per cent	56–73 × 5·5–7·25.
7-septate	27 ,,	60–83 × 5·5–7·25.
8-septate	12 ,,	59–86 × 6·25–7·25.
9-septate	14 ,,	75–90 × 6·25–6·75.

In the South African strains studied, there was a smaller percentage of conidia with 6–9 septations, and the majority were more slender.

Section **SUBMICROCERA.**

Wollenweber, Fusarium-Monographie, 281, 1931. Wollenweber and Reinking, Die Fusarien, 38, 1935.

Comparatively slow-growing fungi, chiefly mycogenous; they are found on dry branches and grasses, chiefly as parasites on other fungi (*Sphaeriaceales*, *Hypocreales*), or on the

thallus of lichens growing on trees. Conidia subulate, slender, thin-walled, pointed at both ends, never pedicillate, indistinctly septate. They occur in reddish, mucilaginous balls, on loose, cotton-wool-like mycelial tufts, or on a stilboid stroma. The latter may be 2 mm. high, and consists of hyphae which are loosely interwoven or coremium-like ; the base is whitish and soft, and looks as if powdered with flour ; often it is thickened bulbously above, and bears spherical balls of plectenchyma, on the surface of which are produced radiating conidiophores in dense clusters. These abstrict conidia in great numbers, and they collect in small drops or mucilaginous balls of an orange red colour. When dry, they form a continuous, adherent, resinous, brick red, crust. Chlamydospores wanting.

Only two species known, *Fusarium ciliatum* Lk., the type species, of which the ascus form is *Calonectria decora* (Wallr.) Sacc., and *F. cerasi* Roll. et Ferry with somewhat smaller, paler, more curved conidia. The latter species occurs in Europe and North America on dead branches of *Prunus cerasus*, *Ceraphora*, *Alnus* and *Corylus*.

Fusarium ciliatum Link.

Link, Spec. Plant. II : 105 (1825) ; Wollenweber and Reinking, Die Fusarien 38–39, 1935 ; Wollenweber, Fus. aut. del. 54, 437, 438, 872, 1128.

Syn. *Attractium ciliatum* Lk. pr. p. ; *Microcera ciliata* (Lk.) Wr.
Fusarium ciliatum Lk. v. *majus* Wr.
Fusarium parasiticum West. ; *F. peltigera* West.
F. scolecoides Sacc. et Ell. ; *F. elongatum* Cke.
F. filisporum (Cke.) Sacc. ; *Fusisporium filisporum* Cke.
Microcera massariae Sacc.

Conidia subulate, small, slender, delicate, straight or curved, tapering to both ends, apedicellate and more or less truncate at the base, in mass bittersweet pink to flame scarlet, fading to orange rufous and rufous when dry. Conidia 3–7- (mostly 5–7-) septate, seldom up to 10-septate or less than 3-septate ; 5-septate 40–90 × 1·9–2·5–3, 7-septate 55–90 × 2·25–2·5. Conidia formed on floccose, loose, mycelial tufts, and adhering in mucilaginous balls, or borne on a coremium-like columnar, stilboid stroma. The conidiophores are simple or branched, and develope on the aerial mycelium, or in close clusters on the swollen, confluent, spherical balls of plectenchyma, which are produced on the top of the stalked stroma. Chlamydospores wanting.

Hab.—On the ascigerous stroma of *Epichloë Zahlbruckneriana* on *Sporobolus indicus* and *Eragrostis plana*, Thornville Junction, Natal, March 1910 (Doidge) M.H. 865 ; Mooi River, Natal, March 1917 (Mogg) M.H. 10063 ; Cramond, Natal, April 1911 (Pole-Evans) M.H. 1369 ; Fairy Glen, Pretoria, March 1923 (Lounsbury) M.H. 17651 ; Acton Homes, Natal. February 1931 (L. A. Doidge) M.H. 25897 ; Hopevale, nr. Donnybrook, Natal (Morgan) M.H. 27749.

Fusarium ciliatum is found very commonly on the stroma of Epichloë, especially in Natal. The organism was identified by Dr. Wollenweber from a culture made from the specimen M.H. 25897. In nature, small patches of white, cottony to arachnoid mycelium appear on the surface of the stroma, rapidly becoming tinged with pink as the conidia develope. These patches consist of tangled hyphae which soon form at their tips a continuous, plectenchymatous layer, which in turn gives rise to very numerous, fasciculate conidiophores. The small patches of mycelium increase in size, coalesce, and often completely clothe the stroma of the host with a waxy or resinous, conidial layer. Occasionally the *Epichloë* stroma developes partially enveloped in the sheath of the grass leaf ; in such a case, there is a layer of white mycelium between the stroma and the sheath, and the pionnotal layer developes on the edge of the sheath.

The fungus occurs in Europe and North America chiefly on *Massaria* and other fungi, on decaying branches of *Acer*, *Alnus*, *Ulmus*, *Fraxinus* and *Robinia*. It is also found on lichens (*Peltigera*) (see Wollenweber, Fus. aut. del. 54, 437, 438, 872).

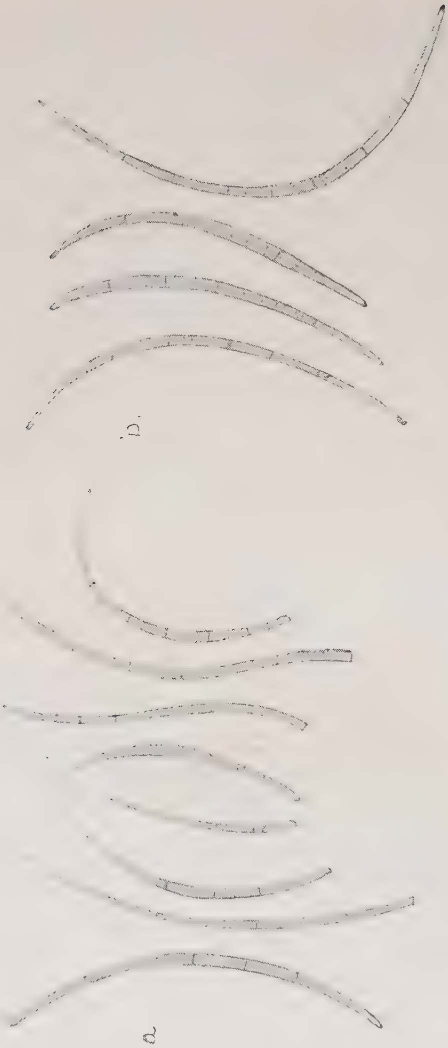

FIG. 3.

Fusarium ciliatum Link.; Macroconidia from (*a*) the conidial mat on the stroma of *Epichloë*, and (*b*) sporodochia of 8 weeks old culture on oat agar.

F. ciliatum is the conidial form of *Calonectria decora* (Wallr.) Sacc. the ascus stage has not yet been observed in South Africa. It may be briefly described as follows:—

Calonectria decora (Wallr.) Sacc.

Saccardo, Michelia 1 : 310, 1872; Syll. Fung. II : 543. Wollenweber and Reinking, Die Fusarien, 39, 1935. Wollenweber, Fus. aut. del. 54.

Syn. *Sphaeria decora* Wallr.; *Nectria decora* (Wallr.) Fuck.
Nectria Massariae Pass. in herb.; *Calonectria Massariae* (Pass.) Sacc.
Calonectria Dearnessii Ell. et Ev.; *C. diminuta* (Berk.) Berl. et Vogl.
Nectria diploa Berk. et Curt. v. *diminuta* Berk.
Creonectria diploa Seav. non Berk. et Curt.
Calonectria agnina (Rob.) Sacc.; *C. pyrrochlora* Sacc.

Perithecia covered with whitish or rosy-white hyphal threads, ovoid, 0·2–0·27 × 0·15–0·24 mm. (average 0·24 × 0·2), fleshy, light orange to wax yellow, later becoming paler, with a darker, definitely orange-red papilla, 70 μ broad, leaving free an ostiole formed of radiating hyphae. Asci club-shaped, 70–96 × 12–18, 8-spored, sessile. Spores more or less distichous, hyaline, narrow-ellipsoid, tapering somewhat to both ends, straight or slightly curved, at first smooth, then minutely verrucose, 1–3-septate, 16–35 × 5–8, (av. 23 × 5·5). Paraphyses filiform.

Conidia and hosts as described above for *Fusarium ciliatum*.

Growth on Standard Media.

Oat agar : Aerial mycelium fairly abundant, white, cottony, tufted. After 14 days, there was a tinge of congo pink in the plectenchymatous layer on the substratum, and conidial masses were beginning to appear. Conidial masses developed very slowly, elevated on mycelial tufts, at first bittersweet pink, then grenadine ; they were up to 2 mm. diameter.

Hard potato agar : Growth rather slow, but otherwise similar to that on oat agar.

Potato agar plus 5 *per cent. dextrose :* Aerial mycelium flesh pink, cottony or mealy after 14 days. Growth in substratum becoming wrinkled and felt-like and tinged buff pink.

Potato plug : Growth advanced slowly and was not vigorous. Mycelium cottony, white, tinged vinaceous pink.

Melilotus stem : Growth slow, mycelium white, cottony.

Bean pod : After 7 days, about one-third of the pod was covered with white, cottony mycelium, and pods were entirely covered in 4 weeks.

Rice : Growth was more vigorous than on the last three media mentioned ; mycelium at first white or tinged with pink, and after 14 days pale flesh colour to flesh colour.

Measurements of conidia.

From pionnotes on stroma of Epichloë, conidia mostly 5–7-septate.

5-septate.......... 40–62·5 × 2–2·5.
7-septate.......... 55–75 × 2·25–2·5.

Oat agar, culture 4 weeks old, conidia from sporodochia.

Conidia most 7-septate.
7-septate.......... 45–72·5 × 2–2·5.
6-septate.......... 66–75 × 2–3. Only occasionally up to 3 μ thick.
5-septate.......... 55–61·25 × 2–3. Only occasionally up to 3 μ thick.
4-septate.......... 45–52·5 × 2.
3-septate.......... 20–40 × 2–2·5.

In the European specimens, conidia are mostly 5-septate, 50–90 × 2·25–2·75.

Section **SPOROTRICHIELLA.**

Wollenweber, H. W., apud Lewis in Maine Agr. Exp. Sta. Bull. 219 : 256, 1913. Sherbakoff, N.Y; (Cornell) Agr. Exp. Sta. Memoir 6 : 183, 1915. Wollenweber and Reinking, Phytopath. 15 : 156, 1925. Die Fusarien, 45–46, 1935 ; Reinking and Wollenweber, Phil. Jour. Sci. 32 : 115, 1927.

Microconidia 1–2-celled, spherical-ovoid, lemon or pear-shaped and also fusoid-ellipsoid. In the species *Fusarium poae* and *F. chlamydosporum*, only a few falcate macroconidia are found scattered in the mycelium ; in the other species they are more or less abundant and are produced in sporodochia and pionnotes. Chlamydospores usually abundant. In this respect the section differs from the *Roseum*-Fusaria, which have no chlamydospores, but somewhat similar macroconidia. It resembles the *Roseum* section in the colour of the stroma,

which is typically carmine to purple red or ochre yellow. From the section *Arthrosporiella* it differs in the occurrence of spherical microconidia and of sporodochial and pionnotal conidial masses.

Fusarium chlamydosporum Wr. et Rkg.

Wollenweber and Reinking, Phytopath. 15 : 156, 1925 ; Die Fusarien, 47–48, 1935. Wollenweber, Fus. aut. del. 883. Reinking and Wollenweber, Phil. Jour. Sci. 32 : 115–116, 1927.

Conidia-bearing mycelium floccose, pale or pink ; growth on substratum plectenchymatous, sometimes forming somewhat verrucose, tubercular, sclerotial bodies ; of various colours, pale, carmine to purple-red, sulphur-yellow, ochre to dark brown. The dark colour is due to the development in the mycelium of numerous chlamydospores ; these are spherical to pear-shaped, smooth, rough or spiny, intercalary or terminal, single, in pairs, in chains or in clusters, 10–16 μ in diameter.

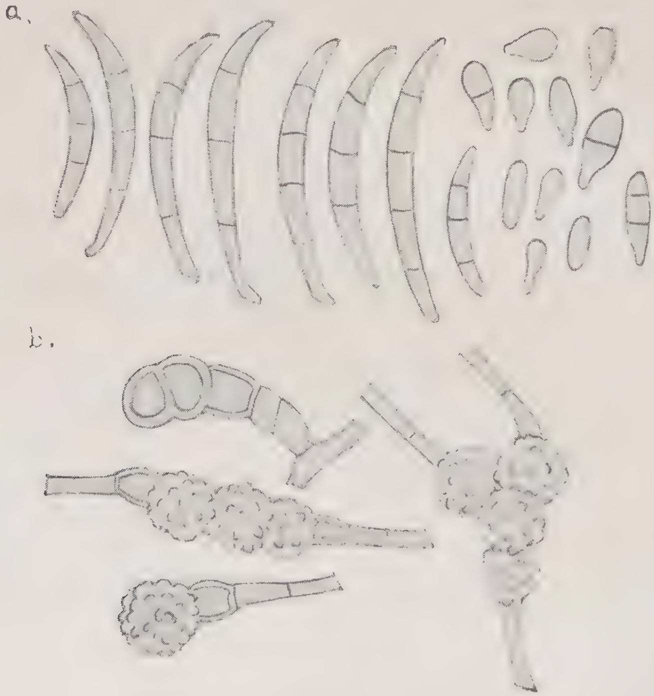

Fig. 4.

Fusarium chlamydosporum Wr. et Rkg. ; (*a*) conidia from mycelium on synthetic agar plus starch, culture 10 weeks old ; (*b*) chlamydospores from culture on plain agar, 6 weeks old.

Microconidia small, fusoid-ellipsoid, not spherical or lemon-shaped, usually 1-celled, seldom septate ; macroconidia scattered, rare, 3-septate, falcate, subpedicellate.

0-septate...................... $4–11 \times 2 \cdot 5–4$ (av. $7 \times 3 \cdot 25$).
1-septate...................... $11–16 \times 3 \cdot 4$ (av. $13 \times 3 \cdot 5$).
3-septate...................... $27–32 \times 3 \cdot 5–4$ (av. 29×4).

Hab.—*Brachiaria pubifolia* Stapf, on ovaries, Nelspruit, E. Transvaal (Liebenburg).

This species has also been observed on dead locusts, *Nomadacris septemfasciata*, in South West Africa (61) ; it was first described from banana stems, and from soil and air in Central America (39).

Growth on Standard Media.

Oat agar: Aerial mycelium fairly abundant, cottony, becoming matted and felt-like, tinged in places with sea-shell pink and a little yellow ochre; sometimes becoming brownish when chlamydospores are abundant. Growth in substratum carmine, with a patch of ochre to buckthorn brown at the top of the slant, where the medium was dry.

Hard potato agar: Aerial mycelium white, cottony; growth in substratum colourless. Reinking and Wollenweber (39) record the development of a cameo pink and spinel red mycelium on this medium.

Standard synthetic agar plus starch: Aerial mycelium moderate, cottony, white, becoming tinged cinnamon buff to clay colour with age. Growth in substratum spinel red to dahlia carmine.

Potato agar plus 5 per cent. dextrose: Aerial mycelium fairly dense, cottony or matted and felt-like, white or tinged with the colour of the stroma. Growth in substratum carmine to ox-blood red, with patches of ochre.

Potato plug: Plugs covered with a cottony mycelium, which was white to buffy brown; there were tinges of carmine or pomegranate purple in the substratum.

Melilotus stems: Growth copious, tomentose, white to buffy brown and buckthorn brown.

Rice: Mycelial growth dense, felt-like on the surface of the medium, at first white and rose pink above, and yellow ochre round the rice grains below. After some weeks, the growth was snuff brown to bistre.

Measurements of Conidia.

Standard synthetic agar plus starch, culture 10 weeks old, conidia from mycelium.

0-septate	$5–15 \times 2·5–4·5$.
1-septate	$10\ 20 \times 4·5$.
2-septate	$12·5–22·5 \times 3·75–4·5$.
3-septate	$20–35 \times 3·5–4·5$.
4-septate	$24–47·5 \times 4·5$.
5-septate	$50 \times 4·75$.

Chlamydospores very abundant, single, in pairs, or in chains and clusters; at first smooth and colourless, becoming golden brown and verrucose when mature, 9–14 μ in diameter.

Section ROSEUM.

Wollenweber, Phytopath. 3 : 32, 1913. Reinking and Wollenweber, Phil. Jour. Sci. 32 : 148, 1927 Wollenweber and Reinking, Die Fusarien, 49–53, 1935.

Macroconidia subulate, slender, thin-walled, only weakly refractive, curved to almost straight, typically of even diameter for a considerable part of their length, tapering gradually to both ends, pedicellate at the base, orange colour or lighter in mass, brick red or reddish brown when dry. Macroconidia borne on the aerial mycelium, on the stroma, or in pionnotes and sporodochia direct on the substratum. When the aerial mycelium is well developed, they may also be scattered in the mycelium or in false heads. Stroma yellow, ochre, carmine red or reddish brown. Aerial mycelium white, pink or yellowish. Blue sclerotial stromata occur occasionally in some species and not at all in others. Chlamydospores wanting. Ascus stage unknown.

Fusarium avenaceum (Fr.) Sacc.

Sacc. Syll. Fung. 4 : 713, 1886. Wollenweber and Reinking, Die Fusarien 53–55, 1935. Wollenweber, Fus. aut. del. 127, 128, 130–136, 139–164, 178–194, 560–568, 572–574, 892, 894–899, 1132, 1133.

Syn. *Fusisporium avenaceum* Fr. ; *Sarcopodium avenaceum* Fr.

Fusarium biforme Sherb. ; *F. effusum* Sherb.

Fusarium herbarum (Cda.) Fr. plus *f. 1* and *f. 2*.Wr., *v. avenaceum* (Fr.) Wr.

v. gibberelloides Wr., *v. graminum* (Cda.) Wr. pr. p.

v. pirinum (Fr.) Wr., *v. tubercularioides* (Cda.) Wr.

v. viticola (Theum.) Wr.

F. heterosporum Nees f. *paspali* Ell. et Ev. ; *F. lucidum* Sherb.

F. metachroum App. et Wr., plus *v. minus* Sherb. ; *F. paspali* P. Henn.

F. sorghi P. Henn. ; *F. subulatum* App. et Wr., plus *v. brevius* Sherb.

F. truncatum Sherb. ; *F. zeae* (West.) Sacc.

For complete synonymy, see Wollenweber and Reinking, loc. cit.

FIG. 5.

Fusarium avenaceum (Fr.) Sacc. ; Conidia from pionnotes of 6 weeks old cultures on (*a*) synthetic agar plus starch and (*b*) oat agar.

Conidia seldom scattered, usually in false heads or balls, or in sporodochia and pionnotes ; the latter are orange or cinnabar-red to scarlet, becoming darker if drying in a resinous mass, or becoming lighter and pink if drying in a powdery condition ; conidial masses may also become tinged with the colour of the stroma. Stroma yellow, ochre, carmine to red brown ; aerial mycelium white, or tinged with the colour of the stroma. True sclerotia, or sclerotially erumpent, rugulose stromata rarely found. Sclerotia, when present, single or in groups, 60–80 μ diam., dark blue or pale. Conidia mostly 3–5-septate, long, subulate or filiform, symmetrically arcuate to elliptically curved, or somewhat more curved near the apex than in the middle ; base more or less pedicellate :

3-septate............	22–61 × 2·3–6, ...	mostly 30–48 × 2·7–3·9.
5-septate............	35–80 × 2·5–6, ...	mostly 45–66 × 3·1–4·4.
7-septate............	61–74 × 3·4–5, ...	mostly 64 × 4·1.
0-septate............	6–17 × 2·5–4, ...	average 11 × 2·9.
1-septate............	10–25 × 2·4–4, ...	average 18 × 3.

Conidiophores simple, or with irregular to fasciculate branching ; branches are irregular or in whorls of 2–4 or rarely 5.

Hab.—*Eleusine indica* Gaertn. (goose grass), from stems of plant dying from attack of *Helminthosporium* sp., Acton Homes, Natal, Jan. 1931 (L A. Doidge).

Puccinia ranulipes Doidge on *Asparagus laricinus*. Poplars near Wonderboom, Pretoria dist., 1937 (in teleutosori).

F. Avenaceum is very widely distributed in the temperate zone, and occurs on a wide range of host plants. It occurs on 150 different genera, including grasses, cereals, crop plants, etc., also on other fungi, e.g., *Meliola, Claviceps, Uredineae.*

Growth on Standard Media.

Oat agar : Aerial mycelium not abundant in cultures made from conidia, copious if grown from a mycelial transfer, fine, floccose, white or tinged with pink. Growth on substratum at first colourless, in four weeks becoming carmine to ox-blood red. Sporodochia apricot-buff to salmon orange, fading to ochraceous orange and cinnamon rufous with age.

Hard potato agar : Like oat agar, but growth in substratum colourless, and sporodochia smaller and less freely produced.

Standard synthetic agar plus starch : Aerial mycelium scanty, white tinged with pink. growth in substratum yellowish, then carmine to pomegranate purple. Pionnotes formed chiefly along the needle track, at first pale flesh colour, then apricot buff to apricot orange.

Potato agar plus 5 per cent. dextrose : Aerial mycelium abundant, tomentose, at first white, then rose pink. Growth in substratum geranium pink to carmine. No spore masses were seen.

Potato plug : Plug covered with abundant white mycelium, becoming matted and felt-like, and tinged with pink where it touched the glass ; stroma carmine. A few large sporodochia developed ; they were apricot buff.

Melilotus stem and bean pod : Growth slow and sparse. Aerial mycelium tomentose, not abundant, white to ochre. No spore masses were observed.

Rice : Mycelium at first white ; aerial mycelium later tinged with pink ; growth on substratum at first flesh pink, then carrot red ; rice grains cream to naples yellow, later becoming wood brown.

Measurements of Conidia.

Oat agar, culture 6 weeks old, conidia from sporodochia :—

5-septate............	42 per cent........	35–51 × 3·5–4·5.
4-septate............	16 ,, ...	29–41 × 3–4.
3-septate............	37 ,, ...	23–36 × 3–4.
0–2-septate..........	5 ,,	

Standard synthetic agar plus starch, culture 4 weeks old, conidia from pionnotes :—

6-septate............	Few...............	52 × 4.
5-septate............	61 per cent........	40–52·5 × 3·75–4·5.
4-septate............	10 ,, ...	32–40 × 3·5–4.
3-septate............	29 ,, ...	25–40 × 2·75–4.
0–2-septate..........	Few.	

The conidia in the only strain studied were smaller than the average for the species. See measurements given in the general description.

Fusarium avenaceum (Fr.) Sacc. **f. 1.** Wr. et Rkg.

Wollenweber and Reinking, Die Fusarien, 55, 1935. Wollenweber, Fus. aut. del. 174–176, 571, 890 1134.

Syn. *Fusarium arcuatum* Berk. et Curt. ; *F. arcuatum* Berk. et Curt. *v. majus* Wr.

F. anthophilum Wr. (non A. Braun).

F. Schiedermayeri (Thuem.)Sacc. ; *Fusisporium Schiedermayeri* Thuem.

This form differs from the species in the colour of the stroma, which is pale, white to flesh colour or yellowish. Conidia in sporodochia and pionnotes orange, 3–5-septate, less frequently 0–1-, or 6–7-septate.

3-septate............	22–48 × 2–5·3.......	Mostly 23–46 × 2·5–4.
5-septate............	24–88 × 2·8–5·5.....	Mostly 40–67 × 2·8–5.
7-septate............	46–91 × 3–5·5.......	Average 65 × 4·2.
9-septate............	65–102 × 3–5.	
0-septate............	8–14 × 1·5–4·7......	Average 10·5 × 3.
1-septate............	12–22 × 2·6.........	Average 17 × 3.

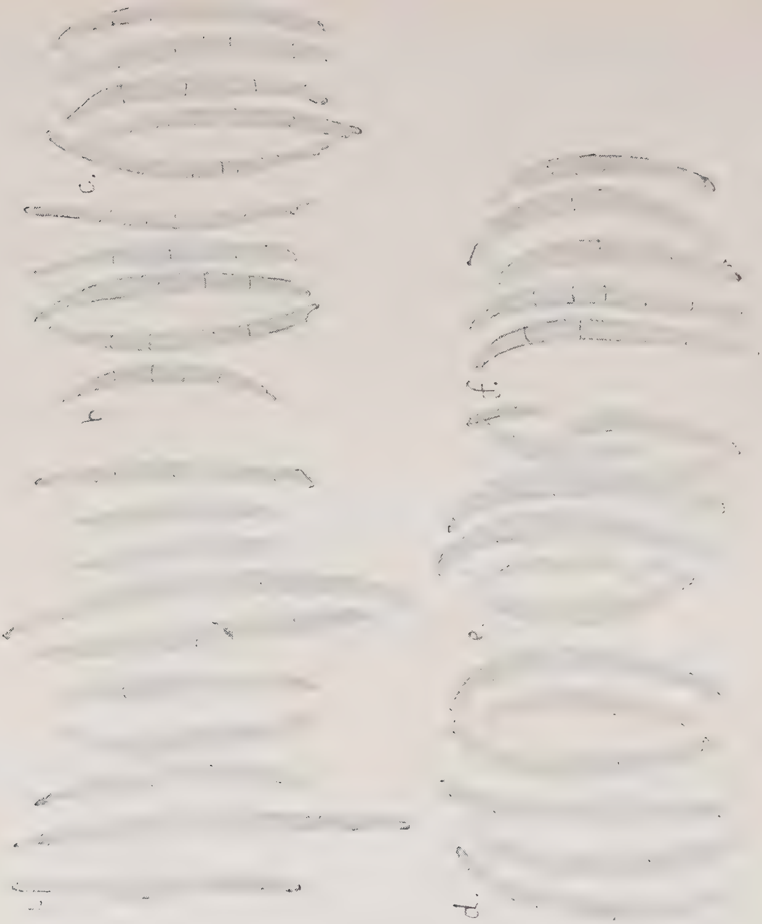

FIG. 6.

Fusarium avenaceum (Fr.) Sacc. *f.1.* et Rkg.; (*a*) conidia from pionnotes on ovaries of *Paspalum* conidia from (*b*) small sporodochium of 4 weeks old culture on standard synthetic agar plus starch; (*c*) small sporodochium of 4 weeks old rice culture; conidia from pionnotes of 2 weeks old culture on (*d*) bean pod (*e*) potato plug and (*f*) Melilotus stem; b-c, culture from *Paspalum*; d-f, culture from *Citrus*.

Hab. *Citrus* sp., from bark of tree, orange on lemon stock, shewing collar rot, Godwan River Estates, E. Transvaal, October 1930 (Marloth).

Euphorbia crassipes Marloth, from decaying stems, Willeston, Cape, M.H. 28379.

Paspalum dilatatum Pair, on ovaries infected with *Claviceps paspali*, Cedara, Natal, January 1930 (Gill), M.H. 25473; Eshowe, Zululand, January 1930 (van der Plank) M.H. 25864.

Paspalum distichum L., on ovaries infected with *Claviceps paspali*, Eastern Vlei, Durban, April 1926 (Kent) M.H. 21105; Umbilo, nr. Durban, April 1926 (Kent) M.H. 23699.

F. avenaceum f. 1. occurs on a number of hosts, usually in the temperate zone, and is less widely distributed than the type species. It is known as a cause of rotting in apples.

Growth on Standard Media.

Oat agar: Aerial mycelium cottony, often tufted, scanty in cultures from conidia, abundant from a mycelial transfer, white, becoming tilleul buff to pale pinkish buff. Growth

in substratum buff pink. Pionnotes and sporodochia, developing freely after 14 days, were buff pink to salmon colour or apricot buff to apricot orange. After 2 months, sporodochia up to 3 mm. in diameter were frequently present in large numbers at the base of the slant; they frequently coalesced to form more extensive conidial layers. In one set of cultures, a tinge of deep delft blue developed in the stroma at the base of the slant after 8 weeks.

Hard potato agar: Aerial mycelium scant to moderate, white, cottony, covering the medium, or developing only near the top of the slants. Sporodochia fairly well developed after 4 weeks, apricot buff to apricot orange, remaining discrete, or coalescing to form a pionnotal layer.

Standard synthetic agar plus starch: Aerial mycelium scant or moderate in amount, cottony, tufted, white, sometimes tinged with barium yellow. Pionnotes well developed after 5 weeks, at first sea-shell pink, then salmon buff. In one set of cultures, there was a patch of blue-black plectenchyma at the base of the slant.

Potato agar plus 5 per cent. dextrose: Aerial mycelium copious, cottony to arachnoid, white to flesh colour and primrose yellow. Growth in substratum pale to flesh colour becoming apricot buff to olive brown with age. The pink colour fades from the aerial mycelium after 12–14 weeks, and it is then white to citron yellow. Groups of sporodochia sometimes developed, they were apricot orange to bittersweet orange.

Potato plug: Plug covered with a moderate to vigorous mycelial growth; this was white to primrose yellow and flesh pink, but the pink colour faded after 14 days, and the mycelium was then white and citron yellow. After 4 weeks the aerial mycelium became rather flattened and felt-like. Growth on substratum pale to flesh colour or naphthalene yellow. Pionnotes developed freely in 14 days and were flesh ochre. In one set of cultures, a few specks of blue-black plectenchyma developed at the back of the plug against the glass.

Melilotus stem: Aerial mycelium scanty to moderate or copious, white, sometimes tinged primrose yellow, cottony to sericeo-tomentose. Pionnotes developed freely after 14 days, flesh ochre. A few blue-black sclerotia developed in one strain.

Bean pod: Mycelial growth moderate to vigorous, short or sericeo-tomentose, white, then primrose yellow in places; pionnotes developing after 14 days, flesh pink; sporodochia forming occasionally, apricot buff.

Rice: Mycelial growth at first white; growth on substratum becoming pale flesh colour to flesh colour; grains becoming naples yellow and then barium yellow. Sporodochia sometimes formed in groups after 14 days; they were numerous, 0·5 to 1 mm. in diameter, or coalescing to form spore masses up to 5 mm. in diam., carrot red to grenadine in colour.

Measurements of Conidia.

A.—Direct from the pionnotal layer on the host, *Claviceps Paspali*.

M.H. 25473.—

5-septate	Few	37–50 × 3·5–4.
4-septate	2 per cent	40–45 × 3–3·7.
3-septate	75 ,,	22·5–42·5 × 2·75–3.
2-septate	6·5 ,,	
1-septate	7 ,,	
0-septate	9·5 ,,	

M.H. 21105.—

7-septate	0·5 per cent	57·5 × 3.
6-septate	0·5 ,,	50–60 × 3·7.
5-septate	7 ,,	37·5–52·5 × 3–5.
4-septate	9·5 ,,	32·5–42·5 × 3–4.
3-septate	78·5 ,,	25–45 × 2·5–3.
2-septate	1·5 ,,	
1-septate	2·5 ,,	

M.H. 23699.—

9–10-septate............	Rare................	80–85 × 4·7–5.
8-septate............	Rare................	70–72·5 × 4–4·5.
7-septate............	0·5 per cent........	60–75 × 3–4·5.
6-septate............	0·5 ,, ...	55–70 × 3–4.
5-septate............	11·8 ,, ...	45–52·5 × 3–4·5.
4-septate............	16·8 ,, ...	37–50 × 2·5–3.
3-septate............	69·6 ,, ...	30–47·5 × 2·5–3.
1-septate............	0·4 ,,	
0-septate............	0·4 ,,	

In the last list of measurements, there is an unusually large percentage of conidia with 4–10 septations, and the higher septate conidia are longer than the average.

B.—Measurements of conidia from cultures (strain isolated from M.H. 25473).

Oat agar, culture 4 weeks old, conidia from sporodochia—

5-septate............	3 per cent........	40–55 × 3–3·75.
4-septate............	19 ,, ...	37·5–52·5 × 2·8–3·75.
3-septate............	77·5 ,, ...	30–52·5 × 2·8–3·75.
1-septate............	0·5 ,,	

Standard synthetic agar plus starch, culture 4 weeks old, conidia from sporodochia—

4-septate............	4 per cent..........	42·5–47·5 × 2·8–3·75.
3-septate............	96 ,, ...	35–47·5 × 2·5–3·75.

Rice, culture 4 weeks old, conidia from sporodochia—

5-septate............	2 per cent........	45–50 × 2·8–3.
4-septate............	24 ,, ...	45–50 × 2·5–3.
3-septate............	72·6 ,, ...	30–47·5 × 2·5–3.
1-septate............	0·7 ,,	
0-septate............	0·7 ,,	

Potato agar plus 5 per cent. dextrose, culture 4 weeks old, conidia from sporodochia—

4-septate............	1·5 per cent........	35–37·5 × 2·5–3.
3-septate............	88·5 ,, ...	21·25–37·5 × 2·5–3.
2-septate............	1 ,,	
1-septate............	8 ,,	
0-septate............	1 ,,	

C.—Measurements of conidia from culture derived from citrus.

Oat agar, culture 4 weeks old, conidia from pionnotes—

5-septate............	10 per cent..........	32–50 × 3·5–4.
4-septate............	28 ,, ...	30–45 × 3–4.
3-septate............	62 ,, ...	22·5–37·5 × 2·5–3·75.

Bean pod, culture 14 days old, conidia from pionnotes—

6-septate............	Few..................	52·5 × 4·7.
5-septate............	74 per cent..........	37·5–55 × 3·75–4·5.
4-septate............	17 ,, ...	35–45 × 3–3·75.
3-septate............	6 ,, ...	22·5–37·5 × 2·5–3·75.
0–2-septate............	3 ,,	

Melilotus stem, culture 14 days old, conidia from pionnotes—

5-septate............	8 per cent..........	42·5–50 × 3·25–3·75.
4-septate............	17 ,, ...	34–47·5 × 3·25–3·75.
3-septate............	70 ,, ...	22·5–45 × 2·5–3·75.
0–2-septate............	5 ,,	

Hard potato agar, culture 14 days old, conidia from pionnotes—

6-septate............	1 per cent..........	50–60 × 3·5–4.
5-septate............	26 ,, ...	40–50 × 3·75–4.
4-septate............	24 ,, ...	40–45 × 3·75–4.
3-septate............	42 ,, ...	25–42·5 × 2·75–4.
0–2-septate............	7 ,,	

Section ARTHROSPORIELLA.

Sherbakoff, New York (Cornell) Agric. Exp. Sta. Memoir 6 : 161, 1915. Wollenweber, Ann. Myc. 15 : 2, 1917 ; Ber. deutsch. bot Ges. 35 : 733, 1918 ; Fusarium-Monographie 324, 1931. Wollenweber and Reinking, Phytopathology, 15 : 157, 1925 ; Die Fusarien, 57, 1935. Reinking and Wollenweber, Phil. Jour. Sci. 32 : 118, 1927.

Aerial mycelium abundant, floccose. Stroma more or less effuse, variable in colour ; it may be light, yellowish, pink or ochre, to light or chestnut brown. Sporodochia typically absent, and pionnotes also usually absent. Conidia usually scattered in the aerial mycelium, of two kinds : Small to medium in size, with 0–3 septations, fusiform, cuneate or lanceolate, apedicellate ; or larger, 3- or more septate, fusiform-falcate, with basal cell conical, constricted or papillate (rarely pedicellate). Chlamydospores intercalary, seldom terminal. Spherical sclerotia occasionally developing, and usually pale or light brown in colour.

Fusarium semitectum Berk. et Rav. var. **majus** Wr.

Wollenweber, Fusarium-Monographie, 325, 1931 ; Fus. aut. del. 113–116, 552, 907–910. Wollenweber and Reinking, Die Fusarien, 59, 1935.

Syn. *Fusarium asparagi* Briard ; *F. incarnatum* (Rob.) Sacc.
Fusisporium incarnatum Rob. ; *Fusarium juglandinum* Peck.
Fusarium oxysporum Schl. subsp. *aurantiacum* Sacc. (non Corda).
F. oxysporum Schl. *v. aurantiacum* f. *hyalina* Brun.
F. pallido-roseum (Cke.) Sacc. ; *Fusisporium pallido-roseum* Cke.
Fusarium roseum Lk., v. *calystegiae* Sacc.

Aerial mycelium white to flesh-colour or isabellinous ; stroma plectenchymatous, light brown or pink. Chlamydospores intercalary. Sporodochia wanting. Conidia powdery, scattered in the aerial mycelium, or adherent in clusters or false heads, salmon pink in mass ; 5-septate, or less frequently 3–4-, occasionally 6–10-septate, intermingled with smaller, 0–2-septate forms. Macroconidia fusiform to lanceolate, straight or slightly curved, usually conical at the base, sometimes papillate, exceptionally pedicellate.

0-septate............	5–15 × 2–4..........	Mostly 6–12 × 2·2–3·2.
1-septate............	9–24 × 2·5–4........	Mostly 14–21 × 2·5–3·2.
3-septate............	13–40 × 2·5–4·8.....	Mostly 19–29 × 3–4·5.
5-septate............	29–52 × 2·5–6.......	Mostly 30–48 × 3·7–4·8.
7-septate............	45–70 × 3·7–6·2.....	Mostly 44–61 × 4·3–6.
9-septate............	50–70 × 4–6.........	Average 60 × 5·3.

Hab. *Citrus Limonia* Osbeck, from collapsed fruit from Sunday's River, Cape, after seven weeks in storage.

Citrus sinensis Osbeck, in decaying fruits ; from stem end and navel end rot of oranges, after 12–18 weeks in storage (7 isolations) ; in navel oranges from White River, E. Transvaal, Zebediela and Letaba, N. Transvaal, and from Sunday's River, Cape.

On twigs dying back ; Hankey, Cape (van der Plank) ; Ofcalaco, N. Transvaal (van der Plank), July 1930, M.H. 28400.

Dianthus caryophyllus L., from stems of wilting plants, Durban (McClean).

Striga lutea Lour., from stems of dying plants, Ixopo, Natal (Mack).

Glossina sp., from dead Tsetse fly, Zululand, 1931 (Harris) M.H. 28446.

Musa Sapientum L., from surface of fruit, Acornhoek (Boyce).

Nomadacris septemfasciata, on red locusts dying from the attack of *Beauvaria* sp., Pretoria dist., 1933.

Eggs, from purplish-brown, discoloured patches of membrane, which at this point adhered to the shell, albumen partially coagulated (ass. *F. moniliforme*), sent by Poultry Inspector, Port Elizabeth (Bottomley).

This species is a common saprophyte on old, dry parts of plants, and on decaying fruit, in all parts of the world.

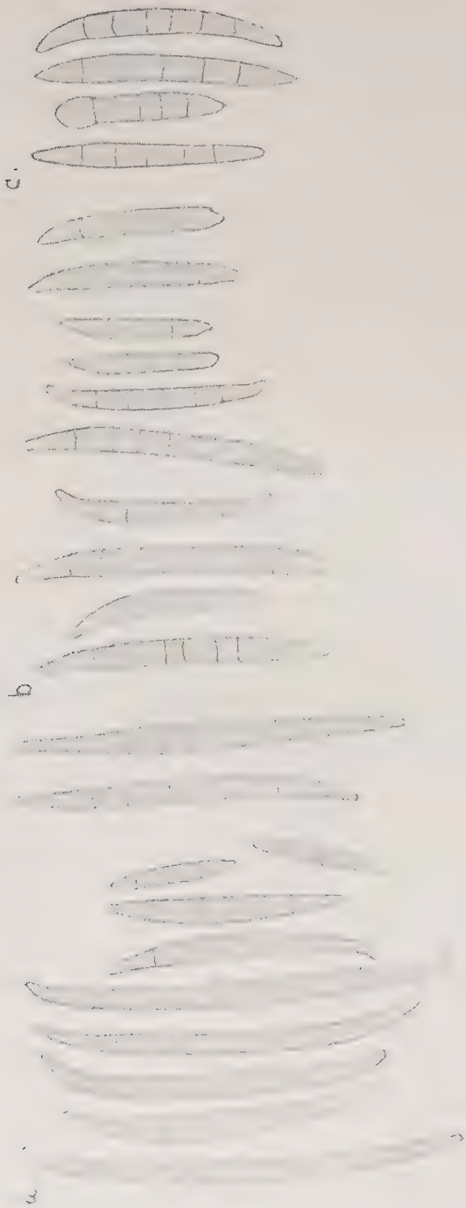

FIG. 7.

Fusarium semitectum Berk. et Rav. v. *majus* Wr.; conidia from mycelium of 2 weeks old culture on (*a*) synthetic agar plus starch (*b*) oat agar and (*c*) bean pod.

Growth on Standard Media.

Oat agar: Aerial mycelium rather scant, white, cottony, becoming mealy-looking after 14 days, owing to the production of clusters of conidia in the mycelium. Growth on substratum light pinkish cinnamon, sometimes with a line of sepia at the base of the slant.

Hard potato agar : Aerial mycelium short, white, becoming mealy-looking, longer and cottony near the top of the slant. Growth flesh pink when conidia are freely produced.

Standard synthetic agar plus starch : Aerial mycelium scant, white, cottony ; growth in substratum white to light pinkish cinnamon.

Potato agar plus 5 per cent. dextrose : Aerial mycelium copious, fine, cottony ; at first white, after 7 days tinged naples yellow and pale salmon colour ; later it may become pale to dark olive buff or brownish olive, the darker colour at the base of the slant. Growth in substratum at first salmon colour to flesh ochre, later it may become citrine drab to brownish olive. Aerial mycelium often mealy in appearance, owing to the formation of conidia.

Potato plug : Plug covered with a copious growth of white, cottony mycelium ; later it becomes felt-like and wrinkled, or mealy-looking if conidia are present. Growth in substratum flesh colour to flesh ochre, sometimes becoming deep olive or buff to buffy brown with age. When conidia are produced freely in the aerial mycelium, they are pale pinkish cinnamon in mass.

Melilotus stem : Aerial mycelium moderate in amount, white to dirty-white, or tinged ochre, tomentose or sericeo-tomentose.

Bean pod : Aerial mycelium vigorous, tomentose to mealy, white, or tinged salmon colour and pinkish buff owing to the presence of numerous conidia.

Rice : Growth at first white to flesh pink, and rice grains naples yellow. Growth may remain pink or become wood brown to natal brown, with the grains also brown. Powdery spore masses are white to pale pinkish cinnamon.

Measurements of Conidia.

Bean, culture 4 weeks old, conidia from mycelium—

8-septate	Few	75 × 4.
7-septate	Few	55–75 × 3–4.
6-septate	Few	45 × 4.
5-septate	39 per cent	25–62·5 × 3–5.
4-septate	7 ,,	25–35 × 3·5–4.
3-septate	30 ,,	20–32·5 × 2·5–4.
2-septate	1·5 ,,	15–20 × 3–4.
1-septate	18 ,,	8–20 × 2–4.
0-septate	4·5 ,,	7·5–10 × 2–4.

Hard potato agar, culture 4 weeks old, conidia from mycelium—

7-septate	1 per cent	62·5–70 × 3·2.
6-septate	2 ,,	55–62·5 × 3–4.
5-septate	52 ,,	35–60 × 3–4.
4-septate	3 ,,	30–40 × 3–4.
3-septate	37·5 ,,	20–50 × 3–3·75.
0–2-septate	4·5 ,,	

Standard synthetic agar plus strach, culture 4 weeks old, conidia from mycelium—

8-septate	Rare	55 × 3·4.
7-septate	1 per cent	65–80 × 3·75–4.
6-septate	6 ,,	57·5–72·5 × 3–3·75.
5-septate	20 ,,	30–55 × 3 4·7.
4-septate	7·5 ,,	30–45 × 2·8–3·7.
3-septate	60 ,,	25–30 × 3–5.
0–2-septate	5·5 ,,	

A few intercalary chlamydospores were observed on plain agar plates.

Section GIBBOSUM.

Wollenweber, Fusarium-Monographie 328, 1931. Wollenweber and Reinking, Die Fusarien 61–62, 1935.

Aerial mycelium white or brownish, less frequently yellow, pink or carmine. Stroma ochre to blackish brown, sometimes golden yellow to carmine red; plectenchymatous stroma may, or may not be rugulose and sclerotially erumpent; spherical, brown or dark blue sclerotia present or absent. Microconidia scattered more or less freely in the young mycelium, disappearing later. Macroconidia in sporodochia and pionnotes, also found in false heads and clusters, or in a loose powder on the mycelium; in mucilaginous masses, the conidia are isabellinous to ochre and orange red; when dry and powdery, they are light-coloured, brownish white. Typical conidia thin-walled, but distinctly 3–5–7- or more septate, dorsiventral, slender, more or less falcate, with parabolic or hyperbolic curvature, sometimes with rather acutely arched dorsal line and somewhat less curved ventral line, tapering at both ends, with filiform or flagelliform apical cell, and very definitely pedicellate base. Chlamydospores intercalary, seldom terminal, in conidia and mycelium, spherical, single, in chains or in clusters, brown in mass. The ascus stage is *Gibberella*.

Key to South African Species.

A.—Curvature of macroconidia more or less parabolic or falcate.
  B.—Macroconidia 3 (3–5) septate: 3-sept. 33×4: 5-sept. $46 \times 4 \cdot 6$ .... *F. equiseti.*
  BB.—Macroconidia 3–5-sept.: 3-sept. $33 \times 3 \cdot 75$: 5-sept. $42 \times 4 \cdot 3$ .... *F. equiseti* v. *bullatum.*
AA.—Curvature of macroconidia more or less hyperbolic. Conidia 5-septate.
  B.—5-septate conidia $43 \times 4 \cdot 4$, comparatively compact, 8–9 times as long as broad .... *F. scirpi* v. *compactum.*
  BB.—5-septate conidia comparatively slender, 10–12 times as long as broad.
    C.—Stroma not carmine to yellow .... *F. scirpi.*
    CC.—Stroma carmine to yellow .... *F. scirpi* v. *acuminatum*
  BBB.—5-septate conidia very long and slender, 14–21 times as long as broad .... *F. scirpi v. filiferum.*

Fusarium equiseti (Cda.) Sacc.

Saccardo, Syll. Fung. 4: 707, 1886. Wollenweber, Fusarium-Monographie, 330, 1931; Fus. aut. del. 202–208, 210, 211, 596, 597, 919, 920. Wollenweber and Reinking, Die Fusarien, 63–65, 1935.

Syn. *Fusarium equiseti* (Cda.) Sacc. *f. 1.* Wr.; *Selenosporium equiseti* Cda.
Fusarium Cordae Mass.; *F. falcatum* App. et. Wr.
F. falcatum App. et Wr. v. *fuscum* Sherb.
F. mucronatum Fautr. in herb. pr. p.; *Fusoma pallidum* Bon.
Fusarium ossicolum (Berk. et Curt.) Sacc.; *Fusisporium ossicola* Sacc.

Conidia sparse at first, scattered in the mycelium, which is white to yellowish, or pink; they are 1-celled or septate, oval or oblong to fusiform-falcate, sometimes comma-shaped, and they disappear when the typical macroconidia begin to develop. Stroma pale or brown, not carmine red, and of varying extent. Macroconidia in tubercular sporodochia, in pionnotes or in clusters, seldom powdery and scattered in the mycelium; in mass they are at first pale, almost mealy white, then ochre to salmon pink; when dry, the spore masses are honey colour to cinnamon brown or lighter. Macroconidia typically fusiform, thick in the centre and tapering gradually to each end, curvature parabolic, straight or bent at the apex and tapering to a fine point, pedicellate at the base; dorsal side usually more strongly

curved than the ventral side; cells more or less equal, cross walls seldom more closely crowded in the centre than at the ends; mostly 5-septate, seldom 3-4-, exceptionally up to 12-septate.

0-septate............	7–18 × 2·5–6.........	Average 12 × 2·5.
1-septate............	12–24 × 2–4.........	Average 16 × 3.
3-septate............	12–44 × 2·3–5·5.....	Mostly 15–36 × 2·5–4·8.
5-septate............	26–74 × 2·8–5·7.....	Mostly 29–56 × 3-5·3.
7-septate............	42–80 × 4–6.........	Mostly 52–62 × 4·2–5·3.
8–12-septate.........	Up to 83 × 5·5.	

Fig. 8.

Fusarium equiseti (Cda.) Sacc.; conidia from (*a*) mycelium of culture on plain agar, 5 days old; (*b*) pionnotes of 2 weeks old culture on synthetic agar plus starch; (*c*) sporodochia of 8 weeks old culture on oat agar; chlamydospores from (*d*) culture on plain agar, 5 days old, and (*e*) culture on hard potato agar, 4 weeks old.

Conidiophores simple or branched; branches spreading or fasciculate, arranged in successive whorls of 2–3 or more, and bearing at their tips groups of 1, 2 or 3 sterigma-like pegs to each ultimate branch. Chlamydospores 6–14 μ in diameter, round, smooth or rough, more frequently intercalary than terminal, sometimes 1-celled, but usually in chains or clusters; brown in mass.

Hab. *Citrus sinensis* Osbeck, from Valencia oranges shewing stem end rot after 12–18 weeks in storage; oranges from Zebediela, N. Transvaal, 1933.

Cucumis sativus L., from stems of wilting plant, Uitenhage, Jan. 1935 (Haines).

Lycopersicum esculentum Mill., from tomato seed offered for sale, Pretoria, 1931 (Wager); from petioles of dying plants, Gqaga, Transkei (Wager).

Striga lutea Lour., from stems of dying witchweed plants, Ixopo, Natal (Mack.).

Growth on Standard Media.

Oat agar: Aerial mycelium abundant, cottony, white to pale pinkish buff and pinkish buff; growth on substratum congo pink. A few small salmon-buff sporodochia developed in two months.

Hard potato agar: Aerial mycelium sparse to moderate in amount, cottony to arachnoid, white; growth in substratum colourless.

Standard synthetic agar plus starch: Aerial mycelium sparse, white, in scattered tufts. Pionnotes began to appear after 8 days, and were well developed after 15 days; they were light vinaceous cinnamon.

Potato agar plus 5 *per cent. dextrose:* Aerial mycelium fairly abundant, cottony, white to pale flesh colour; aerial mycelium and growth in substratum became brown with age.

Potato plug: The plug became covered with a dense, matted, cottony mycelium, which was at first white to seashell pink; the pink colour soon faded. Growth on substratum isabella colour to light brownish olive. A few salmon buff sporodochia developed after 21 days.

Melilotus stem: Aerial mycelium fairly copious, white. A few flesh ochre sporodochia developed on some twigs, and on others a fairly extensive pionnotes.

Bean pod: Aerial mycelium abundant, cottony to arachnoid; at first white to shell pink, soon becoming ochraceous buff and clay colour. No conidial masses seen.

Rice: Mycelium tilleul buff to vinaceous buff, with a ring of buffy brown at the base of the growth.

Measurements of Conidia.

Standard synthetic agar plus starch, culture 15 days old, conidia from pionnotes—

10-septate	0·3 per cent	82 × 5.
9-septate	1 ,,	72·5–75 × 4·5–5.
8-septate	2 ,,	65–75 × 4·5–5.
7-septate	16·3 ,,	52·5–75 × 4–5.
6-septate	12·3 ,,	50–62·5 × 4–5.
5-septate	58·4 ,,	35–57·5 × 3·75–5.
4-septate	7·3 ,,	30–40 × 3·75–4·5.
3-septate	2·4 ,,	22·5–27·5 × 3·75–4.

Potato, culture 9 weeks old, conidia from sporodochia—

7-septate	2 per cent	40–52·5 × 3·75–5·8.
6-septate	3·5 ,,	37·5–50 × 3·75–5.
5-septate	66 ,,	26·25–57·5 × 3·75–5·8.
4-septate	6·5 ,,	22·5–40 × 3·5–5·8.
3-septate	14·5 ,,	15–32·5 × 3·75–5.
2-septate	4·5 ,,	20–27·5 × 3·5–4.
1-septate	3 ,,	10–30 × 3·5–4.

Fusarium equiseti (Cda.) Sacc. var. **bullatum** (Sherb.) Wr.

Wollenweber, Fusarium-Monographie, 331, 1931; Fus. aut. del. 117, 290, 913–918. Wollenweber and Reinking, Die Fusarien, 64–65, 1935.

Syn. *Fusarium bullatum* Sherb.

F. bullatum v. *roseum* Sherb. and v. *roseo-bullatum* (Sh.) Wr.

F. bullatum Sherb. v. *brevius* Wr. et Rkg., and v. *minus* Wr. et Rkg.

F. equiseti (Cda.) Sacc. v. *bullatum f. 1.* et *f. 2.* Wr.

F. nectriae-palmicolae P. Henn.; *F. terrestris* Manns.

The conidia of this variety are, on the whole, somewhat less curved than those of the type species, and of other members of the *Gibbosum*-section; the foot at the base of the conidium is less sharply defined. The septation is inclined to be lower than in the typical *F. equiseti*, and in the mycelial stage, there are often produced lanceolate forms, recalling the conidia of the *Arthrosporiella-Fusaria*, or forms resembling the sub-normal conidia of the *Discolor*-Fusaria. Typical conidia from sporodochia and pionnotes measure—

5-septate............ 31–47 × 4–4·9....... Average 42 × 4·3.

3-septate............ 30–36 × 3·7–3·8..... Average 33 × 3·75.

They are cream to salmon colour in mass. Chlamydospores are mostly intercalary, in chains, or in small or large clusters. Aerial mycelium is usually abundant, of average height and density, and almost pure white in colour. The stroma is pale to brown, and the substratum often absorbs the colour of the stroma.

FIG. 9.

Fusarium equiseti (Cda.) Sacc. v. *bullatum* (Sherb.) Wr.; conidia from sporodochia of 4 weeks old cultures on (*a*) standard synthetic agar plus starch, (*b*) oat agar, and (*c*) Melilotus stem.

Hab. *Mesembrianthemum* sp., from rotting stems of succulent plants, Pretoria (Wager).

This variety occurs on decaying parts of plants belonging to a number of different genera, in tropical and sub-tropical countries. It is known in Asia and America, and occurs occasionally on scale insects.

The ascus stage is *Gibberella intricans* Wr., which is said to develop freely in pure cultures. It has not been observed in South Africa, either occurring naturally or in pure culture. It may be briefly characterised as follows:—

Gibberella intricans Wr.

Wollenweber, Fusarium-Monographie 332, 1931; Fus. aut. del. 810. Wollenweber and Reinking, Die Fusarien, 65–66, 1935.

Perithecia solitary or in groups, ovoid, rugulose, ostiolate, 0·17–0·4 × 0·15–0·3 mm., usually 0·3–0·35 × 0·18–0·24 mm., blue-black; asci spuriously paraphysate, clavate, 8- or 4-spored, rarely 2-spored, monostichous or obliquely distichous; sporidia 3-septate, rarely 1–2- or 4–7-septate, fusoid, more rarely straight than curved, slightly falcate, conical at both ends; 3-septate sporidia 19–36 × 3·7–7, mostly 21–33 × 4·1–5·6.

The *Gibberella*-stage was first observed on dry leaves of banana (39).

Growth on Standard Media.

Oat agar: Mycelium white, tomentose, fairly abundant; growth in substratum colourless. Pionnotes, forming freely after 14 days, were light ochraceous salmon.

Hard potato agar and standard synthetic agar plus starch: Growth on these media resembled that on oat agar.

Potato Agar plus 5 per cent. dextrose: Aerial mycelium white, tomentose; Growth on substratum at first white to cream colour, becoming salmon colour, and, after 4 weeks, pale pinkish cinnamon to dark olive buff.

Potato plug: After 14 days, the plug was covered with a vigorous growth of white, tomentose mycelium.

Melilotus stem: After 14 days, the stems were covered with a white, tomentose to sericeo-tomentose mycelium; pionnotes, pinkish buff in colour, developed after 4 weeks.

Bean pod: Growth similar to that on *Melilotus* stems.

Rice: After 14 days, the growth was white to tilleul buff; after 4 weeks, the colour deepened to wood brown in places.

Only one strain of this variety was studied, and in this, the colour of the stroma was somewhat lighter than that of strains studied elsewhere (39).

Measurements of Conidia.

Oat agar, culture 4 weeks old, conidia from pionnotes—

5-septate............	27 per cent........	25–40 × 3–3·75.
4-septate............	56·5 ,, ...	22·5–37·5 × 3–3·75.
3-septate............	16·5 ,, ...	17·5–25 × 3–3·75.

Standard synthetic agar plus starch, culture 4 weeks old, conidia from pionnotes—

5-septate............	36 per cent..........	31-47·5 × 3–4·5.
4-septate............	50 ,, ...	30–35 × 3–3·75.
3-septate............	14 ,, ...	22·5–30 × 3–3·75.

Melilotus stem, culture 4 weeks old, conidia from pionnotes—

5-septate............	23 per cent..........	30–37·5 × 3–4.
4-septate............	50 ,, ...	25–35 × 3–3·75.
3-septate............	25·5 ,, ...	20–30 × 3-3·5.
1-septate............	1·5 ,,	

Fusarium scirpi Lamb. et Fautr.

Lambotte et Fautrey, Rev. Mycol., 111, 1894. Wollenweber, Fusarium-Monographie, 334-335, 1931; Fus. aut. del. 198–201, 212–218, 595, 598, 926–929, 1137. Wollenweber and Reinking, Die Fusarien, 66, 1935.

Syn. *Fusarium scirpi* Lamb. et Fautr. *f. 1.* Wr.; *F. sclerotium* Wr.

F. scirpi Lamb. et Fautr. v. *nigrantum* (*-nigrans*) Benn.

F. scirpi Lamb. et Fautr. v. *pallens* Benn., and v. *comma* Wr.

F. gibbosum App. et Wr.; *F. aleyrodis* Petch.

Fusarium sclerodermatis Oud. v. *lycoperdonis* Pieb.

F. chenopodinum (Thuem.) Sacc.; *Fusisporium chenopodinum* Thuem.

Fusoma helminthosporii Corda.

Fusarium roseum Lk. f. *solani nigri* Sacc. in Myc. Ven. 367.

Sporodochia pale, yellowish pink or ochre to salmon colour; at first they are minute bodies the size of a pin's head, and soon become dry and powdery, or, if moist, coalesce into an extended pionnotes. Spore masses, when dry, are pale to light brown, or occasionally cinnamon brown. Aerial mycelium loose, cottony or filamentous, light or brownish, later disappearing. Stroma brown, rarely with blue-black spherical sclerotia. Conidia resemble those of *F. equiseti*, but the apical cell is more prolonged and pointed, and the curvature of the dorsal side is strongly hyperbolic; the cross-walls are more numerous, and are more

closely crowded in the middle of the conidium than at the ends. Scattered microconidia are at first comparatively abundant, 0–3-septate, oval, fusiform, reniform or comma-shaped, and also club-shaped to lanceolate. Macroconidia produced in sporodochia and pionnotes typically falcate, mostly 5-septate, more rarely 3–4- or 8–11-septate.

0-septate............	5–12 × 2–4..........	Mostly 6–10 × 2·4–3·5.
1-septate............	8–20 × 2–4..........	Mostly 10–15 × 2·7–3·5.
3-septate............	10–55 × 2·5–7·3.....	Mostly 17–44 × 3·3–4·5.
5-septate............	20–73 × 3–6.........	Mostly 22–66 × 4–5·3.
8-septate............	30–75 × 3·8–6.......	Mostly 36–71 × 4·2 5·5.
9-septate............	51–83 × 4·5–6.......	Mostly 67 × 5·2.

Chlamydospores intercalary, seldom terminal, mostly in chains or clusters, brown in colour; rarely single, round and 7–14 μ diam. Sclerotia, when present, spherical, brown to dark blue, 60–80 μ diam.

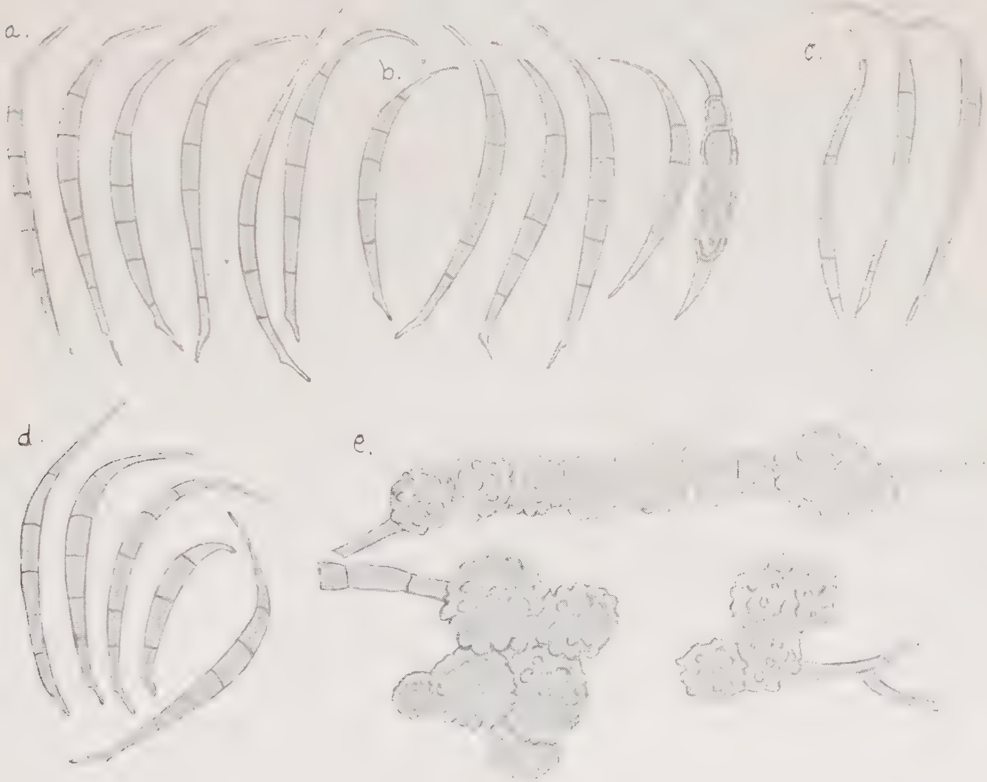

Fig. 10.

Fusarium scirpi Lamb. et Fautr.; Conidia from (*a*) sporodochia of 4 weeks old culture on standard synthetic agar plus starch, (*b*) pionnotes of 4 weeks old culture on oat agar, (*c*) pionnotes of 2 weeks old culture on hard potato agar, (*d*) minute sporodochia of 2 weeks old rice culture; (*e*) chlamydospores from 4 weeks old culture on potato plug.

Hab. *Allium cepa* L., from rotting stems of seedlings, Pyramids, Pretoria dist., March 1932 (Mogg).

Antirrhinum majus L., from stems of wilting plants, Wepener, O.F.S., Pretoria, Transvaal, and Carnarvon, Cape (Wager).

Arachis hypogaea L., on pods and seeds of peanuts attacked in the soil, Pretoria University Farm, 1932 (F. du Toit).

Callistephus chinensis Nees, from stems of wilting aster seedlings, Pretoria (associated with *Rhizoctonia* and *Pythium* sp.); Hennops River, Pretoria dist. (Havenga).

Carica papaya L., from rotting pawpaw fruit, Buffelspoort, nr. Marikana, and Warmbaths, Transvaal.

Centaurea cyanus L., from discoloured stem of cornflower, Johannesburg (Wager).

Citrus grandis Osbeck, from bark of grapefruit tree showing gummosis, Patentie, Cape, July 1930.

Citrus Limonia Osbeck, from roots of rough lemon stock showing dry root rot, Elandshoek, E. Transvaal, July 1930 (M.H. 28911); Bonnievale, Cape (van der Hoek) M.H. 28430.

Citrus nobilis Lour. var. *deliciosa* Swingle, from twig of naartje tree, associated with *Septobasidium* sp., East London, 1929 (Turner).

Citrus sinensis Osbeck, isolated frequently from oranges showing stem end or navel end rot, after 12–18 weeks in storage (25 strains studied); in fruit from Rustenburg, Zebediela, Transvaal, Groot Drakenstein, Cape, and Muden, Natal.

From bark of orange trees showing root and collar rot, Godwan River, E. Transvaal, October 1930 (van der Plank); Letaba Estates, N. Transvaal (Matthew).

Crotalaria juncea L., from base of stem of wilting plants of Sunn Hemp, University Farm, Pretoria, 1932 (F. du Toit).

Cucumis sativus L., from cucumbers (fruits), shewing soft rot and leaking, Nelspruit, E. Transvaal (Wager); from stems of wilting plants, nr. Port Elizabeth (Haines).

Cucurbita pepo L., on young fruits of vegetable marrow rotting in garden, Irene, nr. Pretoria (Bottomley).

Dianthus caryophyllus L., from stems of dying carnation plants, Golden Valley, Cape (Wager); Hartebeestpoort, Transvaal (associated with *Sclerotium Rolfsii*); Duivelskloof, N. Transvaal (Wager).

Eleusine indica Gaertn., from stems of goose grass (associated with *Helminthosporium* sp.) Acton Homes, nr. Ladysmith, Natal (L. A. Doidge).

Euphorbia crassipes Marloth, from rotting stems of succulent *Euphorbia*, Williston, Cape.

Kentia sp, on stem of dying palm (associated with *Gloeosporium* sp), Uitenhage, Cape, Sept 1932.

Lathyrus odoratus L, from stems of sweet pea seedlings, which were yellowing and dying off (associated with *Pythium* sp), Brooklyn, Pretoria.

Limonium sp., from crown of dying Statice plants, Nelspruit, E. Transvaal (Wager).

Lycopersicum esculentum Mill., from stems of wilted tomato plant, Windhoek, S.W.A. (Wager); petioles of dying plant, Gqaga, Transkei; from decaying stems, Karino, E. Transvaal (Wager), M.H. 28432; from fruits, on "blossom end rot" lesions, Pyramids, Pretoria dist.

Matthiola incana R. Br., from discoloured stem of stock plant, Johannesburg (Wager).

Musa Sapientum L., from surface of decaying fruit, Acornhoek (Boybe).

Papaver nudicaule L., from crown of dying plants, Brooklyn, Pretoria (Wager).

Phlox Drummondii Hook., from stems of wilting plants (ass. *Rhizoctonia*), Brooklyn, Pretoria.

Pinus sp., from stems of seedlings, dying in nursery, Heidelberg, Transvaal, M.H. 28392.

Pisum sativum L., from stems of dying plants, Carnarvon, Cape (Wager).

Pteridium aquilinum Kuhn, from rhizome of diseased bracken plant (associated with *Pythium* sp. and *Pestalotia* sp.), White River, E. Transvaal (Wager).

Pyrus malus L., from brown cores of fruit, Vereeniging, 1935–6 (Bottomley).

Solanum tuberosum L., on tubers showing "dry rot," and on tubers breaking down with "leak" due to *Pythium* sp., Pretoria.

Viscaria viscosa Aschers., from stems of dying plants, Brooklyn, Pretoria.

Icerya purchasi, on Australian bug, on *Mentha* sp., Grahamstown, 1932 (N. Smith).

Nomadacris septemfasciata, on eggs of red locust, hatching in sterilised soil, Pretoria, 1932 (Brooks).

This cosmopolitan species is extremely common in South Africa on dead or dying parts of plants. It appears frequently to invade plant tissues which have been attacked by other fungi or otherwise injured, and to be a secondary cause of decay.

Growth on Standard Media.

Oat agar : Aerial mycelium not abundant, fine, white, cottony ; after 7 days, very minute sporodochia were developing all over the face of the slant, these were very numerous and in places coalesced, but for the most part remained discrete. Sporodochia pale ochraceous salmon to light vinaceous cinnamon.

Hard potato agar : Aerial mycelium fairly abundant, fine, white, cottony to cobwebby ; after 14 days, a copious pionnotes had developed on the substratum ; this was at first ochraceous salmon, and later salmon buff and vinaceous cinnamon.

Standard synthetic agar plus starch : Aerial mycelium not very abundant, fine, white, cobwebby. Pionnotes copious, in one case showing a tendency to develop in concentric rings round the point of transfer ; pionnotes light ochraceous salmon or buff pink, becoming salmon buff to light vinaceous cinnamon.

Potato agar plus 5 *per cent. dextrose :* After 7 days, aerial mycelium was fairly abundant, white, cottony ; growth on substratum congo pink. After 14 days, growth on the substratum was dark olive buff, and the medium was stained olive brown to vandyke brown.

Potato plug : Aerial mycelium scanty to moderate in amount, cottony to cobwebby at first white, but after 4 weeks, becoming flattened and felt-like, and olive buff in colour, owing to the presence of numerous chlamydospores. Growth on substratum became snuff brown to warm sepia, and the medium was stained buffy brown. Pionnotes developed freely after 7 days, on the substratum, and were buff pink to light vinaceous cinnamon.

Melilotus stem : Aerial mycelium fairly abundant, at first white cottony, but after 4 weeks, rather flattened and felt-like, and brownish white in colour. Pionnotes formed freely, and practically covered the stems ; they were pinkish cinnamon to cinnamon.

Bean pod : Aerial mycelium scant to copious, in the latter case almost filling the tube. Numerous small sporodochia developed, many of which coalesced in patches and formed a continuous pionnotes ; they were pinkish cinnamon to vinaceous cinnamon.

Rice : Mycelium at first white to pale flesh colour ; growth on substratum snuff brown, and grains stained the same colour. After 4 weeks, the aerial mycelium was still white, but shading to snuff brown near the grains. Minute sporodochia were fairly numerous, and were light vinaceous cinnamon ; where the conidia had dried to a powder at the surface of the medium, they were vinaceous pink.

Measurements of Conidia.

Hard potato agar, culture 14 days old, conidia from pionnotes—

9-septate............	Few..................	82·5 × 5.
8-septate............	Few..................	75 80 × 5.
7-septate............	2·5 per cent........	35–67·5 × 3·75–5.
6-septate............	4·5 ,, ...	52-70 × 5.
5-septate............	90 ,, ...	42–62·5 × 3–5, mostly 50–57·5 × 3–4·5.
4-septate............	2·5 ,, ...	42·5–52·5 × 3·75–5.
3-septate............	0·5 ,, ...	30–35 × 3·5–5.

Bean pod, culture 14 days old, conidia from pionnotes—

6-septate............	Few..................	52·5 × 5.
5-septate............	94 per cent..........	37·5–60 × 4–4·5, mostly 40–50 × 4–4·5.
4-septate............	2 ,, ...	37·5–51 × 4–4·5.
3-septate............	4 ,, ...	30–37·5 × 3·5–4.

Melilotus, stem, culture 14 days old, conidia from pionnotes—

6-septate............	1·5 per cent.........	55–62·5 × 4–5.
5-septate............	90 ,, ...	32·5–62·5 × 3·75–5.
4-septate............	5 ,, ...	35–45 × 3·75–5.
3-septate............	3·5 ,, ...	25–37·5 × 3·75–4·5.

On standard synthetic agar plus starch, the conidia from pionnotes were almost all 5-septate, 40–72·5 × 3–4·5 ; other septations were rare. On oat agar, the conidia were also 99 per cent. to 100 per cent. 5-septate ; they were 40–67·5 × 3–4·5.

Fusarium scirpi Lamb. et Fautr. var. **compactum** Wr.

Wollenweber, Fusarium-Monographie, 333, 1931 ; Fus. aut. del. 923–925. Wollenweber and Reinking, Die Fusarien, 66–67, 1935.

Syn. *Fusarium scirpi* Lamb. et Fautr. v. *compactum f. 1.* Wr.

FIG. 11.

Fusarium scirpi Lamb. et Fautr. v. *compactum* Wr. ; Conidia from (*a*) sporodochia of culture on bean pod, (*b*) pionnotes of culture on standard synthetic agar plus starch, (*c*) pionnotes of culture on oat agar, (*d*) pionnotes of culture on hard potato agar. Culture all 2 weeks old.

This variety differs from *Fusarium scirpi* in the form of its macroconidia, which are more compact; they are comparatively short and broad, and the apical cell is not drawn out into a filamentous process. Conidia mostly 5-septate, more rarely 3–4-septate, seldom 0–2- or 6–7-septate.

3-septate............	17–40 × 3·5–6.......	Mostly 25–31 × 4·2–5·4.
5-septate............	30–55 × 3·7–6·5.....	Mostly 36–47 × 4·3–6.
7-septate............	37–52 × 4·5–6.......	Average 42 × 5.

On media rich in carbohydrates, the stroma may assume a carmine red and golden yellow colour, which sometimes deepens to brown ochre. The red colour is sometimes pronounced, but may be weak or absent. The form previously described as *f.* 1 has no red colour in the stroma. Chlamydospores like those of the type, mostly intercalary, and often distinctly verrucose when mature, especially after drying.

Hab. *Antirrhinum majus* L., from stem of wilting plant, Pretoria (Wager).

Campanula medium L., from stem of wilting Canterbury Bell, Kimberley(Wager).

Citrus sinensis Osbeck, from fruit held in storage for 12–18 weeks; from stem end rot of Valencia oranges from Rustenburg and Zebediela, Transvaal, and from navel end rot of navel oranges from Letaba, N. Transvaal.

From bark of branch affected with scaly bark, Mazoe Estates, Rhodesia (Bates); from citrus trunk showing extensive bark lesions and some gummosis, Letaba, N. Transvaal.

Cucumis sativus L., from cucumbers shewing soft rot and leaking, Nelspruit (Wager).

Lathyrus odoratus L., from stems of wilting sweet pea seedlings, Brooklyn, Pretoria (Wager), M. H. 28416.

Limonium sp., from stems and crowns of dying Statice plants, Nelspruit (Wager).

Matthiola incana R. Br., from discoloured stem of stock plant, Johannesburg (Wager).

Papaver Rhoeas L., from stems of Shirley poppy, which was yellowing and dying (ass. *Rhizoctonia*), Pretoria (Wager).

Striga lutea Lour., from stems of dying plants, Ixopo, Natal (Mack).

Growth on Standard Media.

In culture this strain resembles *Fusarium scirpi,* except that in some strains there is carmine or yellow colour in the stroma. In the strains on *Campanula, Cucumis* and *Limonium,* the stroma on oat agar and standard synthetic agar plus starch was eugenia red to pomegranate purple, and it was carmine on potato agar plus 5 per cent. dextrose; the red colour was more definite in some sets of cultures than in others.

Measurements of Conidia.

Standard synthetic agar plus starch, culture 14 days old, conidia from pionnotes—

7-septate............	Rare.	
6-septate............	Rare.	
5-septate............	86 per cent..........	30–47·5 × 3·75–6.
4-septate............	8 ,, ...	25–37·5 × 3·75–6.
3-septate............	6 ,, ...	27·5–30 × 3·75–5.

Hard potato agar, culture 14 days old, conidia from pionnotes—

7-septate............	1 per cent........	46–55 × 5.
6-septate............	1·5 ,, ...	52·5–53 × 5.
5-septate............	81 ,, ...	35–56 × 4–6.
4-septate............	11·5 ,, ...	35–45 × 4–5.
3-septate............	5 ,, ...	20–47·5 × 3·75–5.

Potato plug, culture 14 days old, conidia from pionnotes—

5-septate............	63 per cent..........	27·5–37·5 × 5–6.
4-septate............	15 ,, ...	20–35 × 4·5–5.
3-septate............	22 ,, ...	20–27·5 × 4·5–5.

Plain agar plates, culture 12 days old, conidia from mycelium—

10–12-septate............	9 per cent..........	55–70 × 5–6.
7–9-septate............	16 ,, ...	50–60 × 5–6.
5–6-septate............	65 ,, ...	35–50 × 4·5–5.
3–4-septate............	10 ,, ...	30–35 × 5.

The figures given above are for conidia developing on one set of plain agar plates; on this occasion the conidia formed had a higher number of septations than on any other medium.

Chlamydospores numerous, usually in chains or clusters. In potato cultures 4 weeks old, they were smooth and hyaline, becoming brown and verrucose as they matured, single spores being 10–15 μ diam. Chlamydospores also occurred in the conidia in some of the older cultures.

Fusarium scirpi Lamb. et Fautr. var. **acuminatum** (Ell. et Ev.) Wr.

Wollenweber, Fusarium-Monographie, 335, 1931; Fus. aut. del. 165-168, 170, 569, 930–933. Wollenweber and Reinking, Die Fusarien, 67–68, 1935.

Syn. *Fusarium acuminatum* Ell. et Ev.; *Fusidium aloes* Kalch. et Cke.
Fusarium arcuosporum Sherb.; *F. erubescens* App. et Ov.
F. ferruginosum Sherb.
F. hippocastani (Cda.) Sacc.; *Selenosporium hippocastani* Cda.
Fusarium lanceolatum Pratt; *F. pseudoeffusum* Mur.
F. russianum Manns; *F. sanguineum* Sherb. (non Fries.).

FIG. 12.

Fusarium scirpi Lamb. et Fautr. v. *acuminatum* (Ell. et Ev.) Wr. conidia from pionnotes of 8 weeks old cultures on (*a*) hard potato agar, (*b*) potato agar plus 5 per cent. dextrose, (*c*) bean pod, and (*d*) standard synthetic agar plus starch; (*e*) chlamydospores from 4 weeks old culture on hard potato agar.

Stroma plectenchymatous, of various colours, blood red, purple, yellow, sometimes sclerotially erumpent and dark blue, brown or pale. Aerial mycelium white or pink. Conidia in sporodochia and pionnotes, orange-coloured, falcate, tapering at both ends, apex more or less elongated, base pedicellate or papillate, occasionally rounded to truncate, 5-septate, less frequently 3–4-septate, exceptionally 0–2- or 6–7-septate.

0-septate............	4–12 × 2–5..........	Average 8·6 × 3.
1-septate............	11–12 × 2·2–4.......	Average 15 × 2·8.
3-septate............	16–44 × 2·5–4·5.....	Mostly 24–37 × 3–4·2.
5-septate............	28–61 × 3–5·3.......	Mostly 34–54 × 3·1–4·3.
7-septate............	45–84 × 3·2–5·2.....	Mostly 41–61 × 3·8–5.

Chlamydospores intercalary, mostly in chains and clusters, seldom terminal, in conidia often 1- or 2-celled, spherical, 7–20 μ diam., 1-septate 20–30 × 10–18; brown in mass.

This variety has much the same distribution as the type, and occurs on a number of plants in almost all parts of the world. The ascus stage has been observed in Europe and Australia on *Acer*, *Dahlia* and maize. It may be briefly characterised as follows:—

Gibberella acuminata Wr.

Wollenweber and Reinking, Die Fusarien, 68, 1935. Wollenweber, Fus. aut. del. 1107, 1108.
Syn. *Gibberella saubinetii* (Dur. et Mont.) f. *dahliae* Sacc.
Nectria dahliae Rich.

Perithecia olive-green to blue black, spherical to conical, rough, 0·3–0·5 mm. diam., single or in small groups, loosely attached to the olive-coloured stroma. Asci mostly 8-spored. Spores fusiform, broadly conical at both ends, slightly curved, 3 (1–3) -septate.

3-septate............	17–36 × 4–9.........	Mostly 22–26 × 5–6.
1-septate............	13–25 × 4·9.........	Mostly 16–22 × 5–8.

The ascus stage has not been found in South Africa, but the conidial stage has been isolated from several hosts.

Hab. *Dianthus caryophyllus* L., from stems of carnation plants affected by foot rot or wilt (in the latter case associated with *F. dianthi*), Bethlehem, O.F.S., Sterkstroom, Transvaal, and Estcourt, Natal, Feb. 1936.

Phaseolus sp., from stems of bean plants which made good growth but set no seed, Premier Cotton Estates, Mvamba.

Solanum tuberosum L., from " seed " tubers, imported from Hamburg, Germany.

Zea Mays L., from base of stem of plant affected by foot rot (*F. moniliforme* also isolated) Lourenco Marques (Fuller), M.H. 23222; Premier Mine, Transvaal (Leemann).

Fusidium aloes Kalch. et Cke. (Grevillea, 22, 1880), which is probably a synonym for *Fusarium scirpi* v. *acuminatum*, was collected by MacOwan in South Africa in 1879, on the leaves of *Aloe arborescens* (Herb. MacOwanianum No. 1170; Wr. Fus. aut. del. 167). This number is unfortunately missing from the collection of MacOwan's fungi in the Cryptogamic herbarium.

Growth on Standard Media.

Oat agar : Aerial mycelium abundant, cottony, mostly white, but with patches of yellow ochre where it touched the tube. Growth in substratum spinel red to pomegranate purple.

Hard potato agar : Mycelium not very plentiful, tufted, cottony. Pionnotes and small sporodochia developed in 2–4 weeks, they were pinkish cinnamon, and developed directly on the substratum; they were partially concealed by the aerial mycelium.

Standard synthetic agar plus starch : Aerial mycelium scanty, white, cottony; growth in substratum isabella colour to old rose and spinel red, or cinnamon rufous in places. After 6 weeks, pinkish cinnamon pionnotes developed in concentric rings round the point of transfer.

Potato agar plus 5 *per cent. dextrose :* After 14 days, aerial mycelium was very plentiful, white to ochraceous buff and Chatenay pink, or occasionally geranium pink; after 4 weeks it was white to spinel red.

Potato plug : Plug covered with a dense, matted mycelium, which was white to sea-shell pink, with patches of chamois colour at the base, and pinkish cinnamon where it touched the glass. Growth on substratum was eugenia red to acajou red.

Melilotus stem : Stems covered with a copious aerial mycelium which was white or tinged with pink.

Bean pod : Pod covered with a copious aerial mycelium, which was cottony to arachnoid and tufted ; it was white to vinaceous buff and vinaceous pink.

Rice : In cultures 10 days old, the mycelium was white at the surface of the medium ; below it was mustard yellow, and, at the base, eosine pink to begonia rose. The pink colour faded after 4 weeks. The mycelium between the grains was then mostly yellow ochre, and the growth in the substratum mummy brown.

Measurements of Conidia.

Standard synthetic agar plus starch, culture 8 weeks old, conidia from sporodochia and pionnotes—

5-septate............	58 per cent..........	28·75–55 × 3–6.
4-septate............	32 ,, ...	30–42·5 × 3–5.
3-septate............	6 ,, ...	22·5–40 × 3–5.
0-septate............	4 ,, ...	13·15 × 3–3·25.

Hard potato agar, culture 8 weeks old, conidia from pionnotes—

6-septate............	3·5 per cent........	27·5–40 × 5–6.
5-septate............	58 ,, ...	25–41·5 × 5–6.
4-septate............	16 ,, ...	20–40 × 4·5–5·5.
3-septate............	16·5 ,, ...	25–38 × 3·75–4·5.
2-septate............	2 ,, ...	25 × 4.
1-septate............	3 ,, ...	12·5–20 × 3·75.
0-septate............	1 ,, ...	15 × 3–3·25.

On plain agar plates, chlamydospores developed after 6 days. They were mostly intercalary, in chains or irregular clusters ; single cells were 5–10 μ diam., sparsely verrucose, becoming olivaceous at maturity.

Fusarium scirpi Lamb. et Fautr. var. **filiferum** (Preuss) Wr.

Wollenweber, Fusarium-Monographie, 337–338, 1931 ; Fus. aut. del. 219–222, 601, 936. Wollenweber and Reinking, Die Fusarien, 69, 1935.

Syn. *Fusarium filiferum* (Pr.) Wr. ; *Fusoma filiferum* Preuss.
Fusarium caudatum Wr. v. *solani* Sherb. ; *F. equiseticola* All.
Fusisporium incarnatum Rob. v. *tussilaginis farfarae* Sacc.
Fusarium mycophytum (W. G. Sm.) Mass. ; *Fusisporium mycophytum* W. G. Sm.
Fusarium osteophilum Speg.

Stroma effuse, sometimes sclerotially erumpent, and then brown ; aerial mycelium white, floccose. Conidia in sporodochia or pionnotes, ochraceous or amber yellow to brown ochre, with whip-like elongation of the apical cell, and base with a long foot. Conidia 5–7-septate, less frequently 3–4- or 8–10-septate, exceptionally up to 12-septate. In young cultures, subnormal, *Fusisporium*-like conidia are found scattered in the mycelium ; they are smaller, oval to fusiform, rounded to conical at both ends, straight or somewhat curved.

0-septate............	5–10 × 2·7–4........	Average 7·7 × 3·3.
1-septate............	9–16 × 3–4..........	Average 13 × 3·5.
3-septate............	19–40 × 2–5.........	Mostly 23–34 × 2·5–4·4.
5-septate............	22–87 × 2·5–6.......	Mostly 35–76 × 3·3–4·5.
7-septate............	50–114 × 3·2–6·5....	Mostly 57–84 × 3·7–5·1.
9-septate............	58–121 × 3·5–6......	Mostly 77–90 × 4–5.
11–12-septate............	60–132 × 3·5–5·5.	

Chlamydospores 6–16 μ in diameter, round or oval, intercalary, smooth or verrucose, usually in chains and clusters.

Hab. *Allium Cepa* L., on rotting stems of onion seedlings, Pyramids, Pretoria dist., March 1932 (Mogg) (seedlings dying from attack of *F. oxysporum f.* 7).

Nomadacris septemfasciata, recorded as occurring on red locusts in South West Africa (Wollenweber and Reinking, loc. cit.).

This variety occurs on decaying parts of plants, and on other fungi, in Europe and North America.

Fig. 13.

Fusarium scirpi Lamb. et Fautr. v. *filiferum* (Wr. et Rkg.) Wr.; Conidia from (*a*) pionnotes of 4 weeks old culture on hard potato agar and (*b*) sporodochia of 4 weeks old culture on oat agar.

Growth on Standard Media.

Oat agar : Aerial myceluim fairly abundant, white, tufted, cottony. Growth in substratum at first colourless, with a tinge of pinkish buff at the base of the slant; after 4 weeks, the stroma at the base of the slant became sclerotially erumpent and brown. Sporodochia few, scattered, cream buff to ochraceous buff.

Hard potato agar : Mycelium white, cottony, not abundant. Growth in substratum colourless. Sporodochia resembled those on oat agar.

Standard synthetic agar plus starch : Aerial mycelium sparse; cultures 14 days old had a tinge of pinkish buff in the substratum at the base of the slant, which faded to ochraceous tawny in 4 weeks.

Potato agar plus 5 *per cent. dextrose :* Aerial mycelium fairly abundant, at first white, later flecked with brown. Growth in substratum at first pinkish buff, becoming ochraceous tawny to snuff brown after 4 weeks; stroma sclerotially erumpent at the base of the slant, as on oat agar. Pionnotes along needle track, russet colour.

Potato plug : Plug covered with fine, cottony mycelium, which was white at first but became brownish with age. There were mummy brown patches in the substratum.

Melilotus stem : Stems covered with a very vigorous, white, cottony mycelium, which completely concealed the sporodochia which developed round the point of transfer.

Bean pod : Pods covered with a fine white mycelium. A number of small sporodochia developed in a group round the point of transfer, elsewhere they were scattered; sporodochia cinnamon colour.

Rice : Growth at first white to pinkish buff, gradually becoming brown.

Measurements of Conidia.

Hard potato agar, culture 14 days old, conidia from sporodochia—

7-septate	5 per cent	56–79 × 4–5·5.
6-septate	10 ,,	55–75 × 3–5.
5-septate	80 ,,	45–72·5 × 3–5.
4-septate	4 ,,	42·5–57·5 × 3·4–5.
3-septate	1 ,,	32·5–40 × 2·8–4·4.

Bean pod, culture 14 days old, conidia from sporodochia—

8-septate	Rare	57·5–60 × 4·7–5.
6-septate	6 per cent	52·5–60 × 3·75–5.
5-septate	86 ,,	35–59 × 2·8–4·7.
4-septate	6 ,,	35–37·5 × 2·8–4·7.
3-septate	2 ,,	32·5–47·5 × 3–3·75.

Section DISCOLOR.

Wollenweber, Fusarium-Monographie, 346, 1931. Wollenweber and Reinking, Die Fusarien, 69–70, 1935.

Macroconidia comparatively thick-walled, fusiform-falcate, tapering at both ends, curved (dorsal side convex, ventral side less curved, usually concave but occasionally somewhat convex); apex constricted like the neck of a bottle, curved and rostrate, or conical to truncate or rounded; base pedicellate, when fully developed and mature. Sporodochia and pionnotes ochre, salmon pink or orange. A few species have a *Fusisporium* stage, with smaller or medium-sized conidia, which are apedicellate, 0–3- or more-septate, oval, fusiform to cylindrical, straight or curved; these forms may predominate, or may disappear with the formation of sporodochia (as in *F. trichothecioides*). Other species have some comparatively slender conidia, and some more compact (*F. heterosporum*). The stroma is flat, effuse; it is plectenchymatous, here and there sclerotially erumpent, and varied in colour; it may be pale, carmine to purple red, yellow, brown, or rarely blue; in a few forms it is pale and homogeneous. Spherical sclerotia may be present or wanting; when present they are blue, brown or colourless. Aerial mycelium well developed, white, pink, or tinged with the colour of the stroma. Chlamydospores few, terminal or intercalary, single, in chain or in clusters; brown in mass. It has been established that the ascus stage of some of the species is *Gibberella*.

Sub-sections of the Discolor-Fusaria.

A.—Apedicellate conidia of the *Fusisporium*-stage predominant. Mycelium floccose, *Trichothecium*-like...... *Trichothecioides*.

AA.—Pedicellate conidia predominant, developing in pionnotes and sporodochia.

B.—Triseptate conidia typically 3–4·1 μ thick....... *Neesiola*.

BB.—Triseptate conidia typically 4·1–7·9 μ thick..... *Saubinetii*.

Key to the South African Species.

A.—Macroconidia 4–5 (5·5) μ thick, 3–5-septate.

B.—Stroma carmine to purple red, chestnut brown, yellow or pink.

C.—Conidia not typically heterosporus, usually in sporodochia.

D.—Conidia comparatively compact, in sporodochia and pionnotes.

E.—Conidia mostly 3-, seldom 4–5-sept.: 3-sept. 25 × 4·9: 5-sept. 30 × 5·3 *F. sambucinum f.* 2.

EE.—Conidia 3–5-sept..................	*F. sambucinum.*
DD.—Conidia comparatively elongated, slender; conidia 3–5-sept......................	*F. graminearum.*
CC.—Conidia typically heterosporous, compact or slender..................................	*F. heterosporum v. congoense.*
BB.—Stroma not becoming carmine to purple red......	*F. sambucinum f.* 6.
AA.—Macroconidia 5–9 μ thick, 5 (3–5–7) -sept..........	*F. culmorum.*

Sub-section NEESIOLA.

Wollenweber, Ann. Myc. 15 : 2, 1917 ; Fusarium-Monographie, 346, 1931. Wollenweber and Reinking, Die Fusarien, 70–74, 1935.

Stroma floccose, effuse, often covered by a pionnotal layer, flat, more rarely sclerotially erumpent. Sporodochia formed less frequently than pionnotes. Conidia slender, 3–4 μ thick, more or less 3-septate, salmon colour, reddish or orange in mass, becoming brick red when dry. Mycelium yellow or flesh colour, rarely carmine. Chlamydospores intercalary or none.

Fusarium heterosporum Nees var. **congoense** Wr.

Wollenweber, Fusarium-Monographie, 350, 1931 ; Fus. aut. del. 306–307, 612, 1140, 1141. Wollenweber and Reinking, Die Fusarien, 73, 1935.

Syn. *Fusarium congoense* Wr. ; *F. congoense* v. *septatius* Wr. (nom. nud.).

F. heterosporum Nees v. *congoense f. 1.* Wr.

Sporodochia orange to brick red, gelatinous, early coalescing to form a pionnotal layer. Conidia typically fusiform to falcate, some compact, others slender, curved, tapering at both ends, pedicellate ; apical cell in the more compact conidia constricted or rostrate ; in the more slender forms tapering gradually and curved ; the slender forms approach the *Roseum* type. Stroma loose, floccose, with abundant aerial mycelium which is white, or citron yellow to sulphur yellow and flesh colour ; plectenchymatous layer on the substratum carmine red. Conidia scattered in false heads or in sporodochia and pionnotes, borne on conidiophores which branch more or less freely. Conidia mostly 3–5-septate, seldom 0–2-septate, or 6–10-septate.

3-septate, 22–40 × 2·7–6, mostly 26–39 × 3·1–5·2 (some compact, av. 29 × 4·8, others more slender, av. 33 × 3·4).

5-septate, 29-45 × 2·7–7, mostly 32–42 × 3·1–5·7 (some 37 × 5·2, others 43 × 3·6).

7-septate, 38–54 × 3–6, mostly 41–45 × 4·1–5·5.

9-septate, 56 × 5·5.

Chlamydospores intercalary.

Hab. *Brachiaria brizantha* Stapf, on ovaries, Experiment Station, Barberton, Transvaal, April 1914 (Mogg) M.H. 7771 ; Salisbury, Rhodesia, March 1919 (Eyles) M.H. 11858.

Brachiaria sp., on ovaries infected with ergot, Salisbury, Rhodesia, Feb. 1915 (Walters) M.H. 8868.

Bromus unioloides H.B.K., on ovaries infected with *Ustilago bromivora*, Rietpoort Zandspruit, Wakkerstroom Dist., Transvaal, April 1907 (Gillespie) M.H. 284-285. (This is apparently the type collection, quoted by Wollenweber in the Fuasrium-Monographie, p. 350, as from " Zandspruit, Wakkerstroom Dist., Congo, Central Africa, Vanderyst F. 284–285 " ; the fungi in the National Herbarium were at one time distinguished by the letter F.).

Cynodon dactylon Pers., on ovaries infected with smut, Skinner's Court, Pretoria, Feb. 1918 (Mogg) M.H. 11673 ; without locality (Burtt Davy) M.H. 577.

Digitaria eriantha Steud., on ovaries, Butterworth, Cape, April 1914 (Pegler) M.H. 7743.

Digitaria monodactyla (Nees) Stapf, on ovaries infected with ergot, Groenkloof, Pretoria, Dec. 1919 (Pole-Evans) M.H. 11874.

Digitaria Pentzii Stent (Woolly Finger Grass), on ovaries infected with ergot, Durban, Feb. 1929 (Clarkson) M.H. 23684; Prinshof, Pretoria, April 1930 (Liebenberg) M.H. 25369.

Hyparrhenia hirta Stapf, on ovaries, Garstfontein, Pretoria Dist., March 1915 (Pienaar) M.H. 8905.

Panicum laevifolium Hack., on ovaries infected with smut, Tzaneen, N. Transvaal, April 1906, M.H. 6.

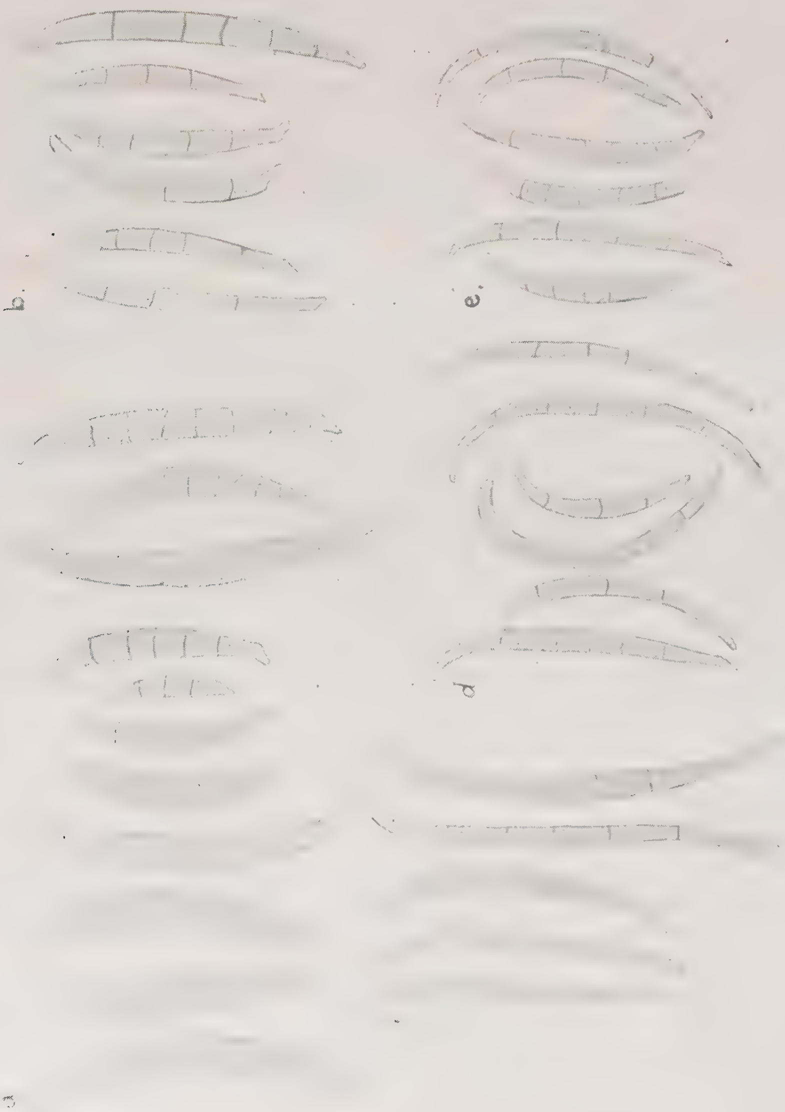

Fig. 14.

Fusarium heterosporum Nees v. *congoense* Wr.; (*a-b*) conidia from natural host, (*a*) stout form, (*b*) slender form; (*c-e*) conidia from cultures; (*c*) from mycelium of 3 weeks old culture on plain agar, (*d*) from sporodochia of 8 weeks old culture on rice, (*e*) from sporodochia of 8 weeks old culture on oat agar.

Panicum maximum Hack., on ovaries infected with ergot, Kentani, Cape, May 1913 (Pegler) M.H. 6649 and 6919; Butterworth, Transkei, April 1914 (Pegler) M.H. 7738; Maritzburg, Natal, April 1914 (Sim.) M.H. 7760; Groenkloof, Pretoria, Feb. 1915 (Pole Evans) M.H. 9058; Moodie's Estates, Barberton, Transvaal, March 1932 (Wager) M.H. 26152.

Pennisetum cenchroides Nees, on ovaries infected with ergot, Prinshof, Pretoria, March 1934 (Mogg) M.H. 26147.

Setaria nigrirostris Dur. et Sch., on ovaries, Leeuwpoort, Carolina Dist., (Burtt Davy) M.H. 480.

Setaria perennis Hack., on ovaries, Groenkloof, Pretoria, Feb. 1919 (Phillips) M.H. 11878.

Setaria sphacelata Stapf et Hub., on ovaries infected with ergot, Garstfontein, Pretoria Dist., March 1915 (Pienaar) M.H. 8906.

Sorghum vulgare Pers. v. *caffrorum* (Thun.) Hubb. et Rehd. (= *Andropogon sorghum*), on ovaries infected with smut, *Sphacelotheca sorghi*, Clercqsvlei, Moedig, Transvaal.

Growth on Standard Media.

Oat agar: Aerial mycelium rather sparse, white, tufted, cottony; after 4 weeks, growth on substratum barium yellow. A number of small, scattered sporodochia developed on the lower part of the slant, and were bittersweet pink in colour.

Hard potato agar: Aerial mycelium sparse to moderate, thin, cottony, white. Very numerous minute sporodochia developed on the lower part of the slant, and were salmon colour.

Standard synthetic agar plus starch: Aerial mycelium fairly plentiful, fine, cottony, white, or tinged thulite pink and naples yellow; growth on substratum spinel red in places. Groups of sporodochia 0·5 to 2·5 mm. in diameter, developed in 4–8 weeks, and were salmon orange to bittersweet pink.

Potato agar plus 5 per cent. dextrose: Aerial mycelium dense, rather tufted, cottony, at first white to safrano pink, grenadine pink and chamois colour. The colour faded somewhat after 14 days, and was then white and pale salmon colour. Growth on substratum eugenia red to pomegranate purple and Bordeaux red. Sporodochia not numerous, bittersweet pink.

Potato plug: Aerial mycelium very abundant, felt-like, white to deep rose pink; growth on substratum pomegranate purple. No spore masses were observed.

Melilotus stem: Aerial mycelium moderate to copious in amount, white, cottony. Sporodochia orange pink.

Bean pod: Mycelium rather abundant, cottony, white, or with patches of salmon buff in places. No conidial masses observed.

Rice: Growth white to spinel red and pomegranate purple; in a second set of cultures, after the fungus had been in culture for some months, the growth was white to flesh colour. In 4 to 8 weeks, a number of sporodochia developed; they were bittersweet pink.

Measurements of Conidia.

A.—Direct from the host.

M.H. 284–285, on ovaries of *Bromus unioloides* (type collection).

Conidia mostly 5-septate, some 3–4- and some 6–7-septate.

6–7-septate..............	37–40 × 5–5·5 or 40–57·5 × 4.
5-septate..............	30–45 × 4–6·25 or 32·5–42·5 × 3–4.
4-septate..............	30–37·5 × 3·7–4.
3-septate..............	25–27·5 × 3·7–5 or 32·5 × 3.

M.H. 8905, on ovaries of *Hyparrhenia hirta.*

Conidia mostly 3–5-septate, some 6–9-septate.

9-septate..............	55–57·5 × 5·5–6.
8-septate..............	45–52·5 × 6·25.
7-septate..............	45–55 × 5–6.
6-septate..............	32·5–47·5 × 5–6·25.
5-septate..............	30–47·5 × 4·5–6 or 37–42·5 × 3·7.
4-septate..............	30–32·5 × 4–5.
3-septate..............	27·5–37·5 × 4–6.

M.H. 11673, on ovaries of *Cynodon dactylon.*

Conidia mostly 3–5-septate.

6–7-septate..............	37·5–40 × 5.
5-septate..............	32·5–42·5 × 5·5–6·25 or 35–37·5 × 3·7–4.
4-septate..............	30 × 5 or 37·5–40 × 3·7.
3-septate..............	30 × 4 or 27·5–40 × 3–3·7.

M.H. 11878, on ovaries of *Setaria perennis.*

Conidia mostly 5-septate, 3–4- and 6–7-septate fairly common, some 8–10-septate.

8–10-septate..............	42·5–57·5 × 5·5–6·26.
7-septate..............	37·5–50 × 5–6.
5-septate..............	27·5–50 × 5–6 or 37·5–50 × 3·7–4.
4-septate..............	37·5–40 × 4·5.
3-septate..............	22·5–27·5 × 5–5·5 or 25–27·5 × 3–3·7.

B.—From culture derived from M.H. 23684, on ovaries of *Digitaria Pentzii.*

Maize stem, culture 6 weeks old, conidia from sporodochia.

5-septate............	73	per cent........	37–45 × 3·4–4.
4-septate............	2·5	,, ...	32·5–45 × 3–3·5.
3-septate............	23	,, ...	25–35 × 3–3·5.
1-septate............	1·5	,, ...	25–35 × 3–3·5.

Hard potato agar, culture 6 weeks old, conidia from sporodochia.

7-septate............	1	per cent........	51–55 × 2·8–3·75.
6-septate............	1	,, ...	52·5–57·5 × 2·8.
5-septate............	52·5	,, ...	32·5–55 × 2·5–3·75.
4-septate............	21·5	,, ...	35–47·5 × 2·5–3·75.
3-septate............	24	,, ...	22·5–40 × 2·3–3·75.

Oat agar, culture 8 weeks old, conidia from sporodochia.

5-septate............	27	per cent..........	32·5–55 × 3·75–4·7.
4-septate............	36	,, ...	37·5–57·5 × 2·5–2·8.
3-septate............	36	,, ...	37·5–51·5 × 2·5–2·8.
2-septate............	1	,,	

Slender forms predominated in culture; the following are measurements of conidia of the same strain from pionnotes on the ovaries of *Digitaria Pentzii*

6–8-septate............	Rare	....	42·5–55 × 3·75–5.
5-septate............	31	per cent..........	35–45 × 3·75–5·25.
4-septate............	16	,, ...	27·5–40 × 2·8–5.
3-septate............	45	,, ...	20–50 × 3·5–4·75.
2-septate............	2	,, ...	22·5–37·5 × 2·8–3·75.
1-septate............	6	,, ...	35–37·5 × 2·5–2·8.

A few intercalary chlamydospores were seen on potato agar plus 5 per cent. dextrose; they were 6–10 μ diam. and rough walled.

Sub-section SAUBINETII.

Wollenweber, Fusarium-Monographie, 346-347, 1931. Wollenweber and Reinking, Die Fusarien, 70, 75, 1935.

Differs from sub-section *Neesiola* in the larger conidia, 4–5–9–13 μ in diameter, and 3–5–7–12-septate, some compact, some more elongated, generally rather pale, yellow-white, pale orange or ochraceous. Stroma carmine or yellow.

Fusarium sambucinum Fuck.

Fuckel, Symbolae myc., 167, 1869. Wollenweber, Fusarium-Monographie, 352–356, 1931; Fus. aut. del. 311–320, 322, 323, 607, 1142–1144. Wollenweber and Reinking, Die Fusarien, 75–76, 1935.

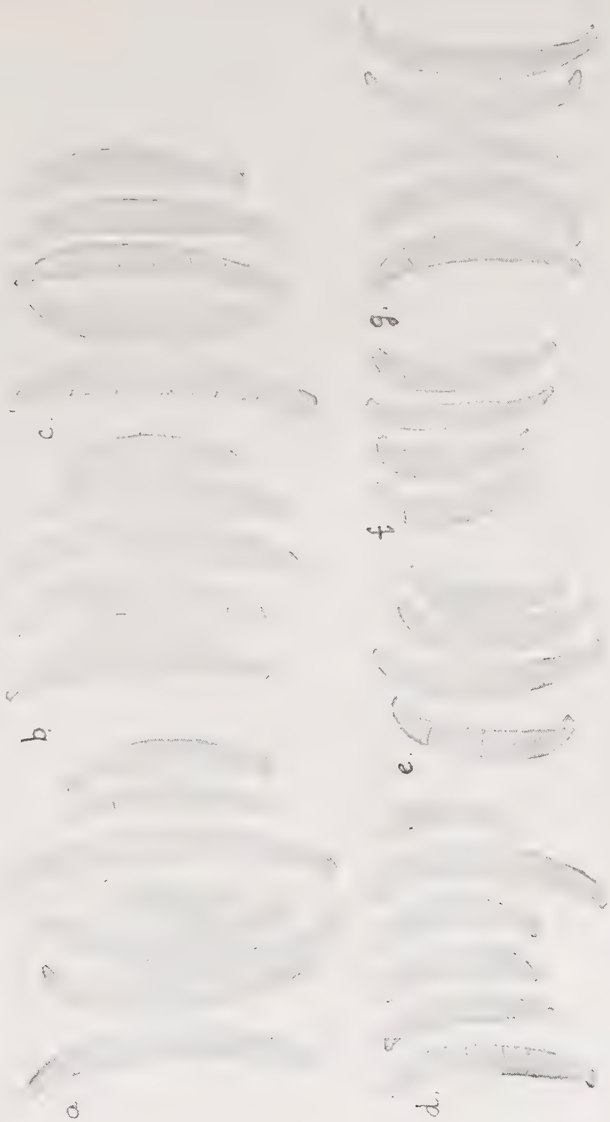

FIG. 15.

Fusarium sambucinum Fuck.; Conidia from (*a*) sporodochia of culture on bean pod, (*b*) pionnotes of culture on oat agar, (*c*) pionnotes of culture on Melilotus stem, (*d*) sporodochia of culture on hard potato agar, (*e*) pionnotes and (*f*) mycelium of culture on standard synthetic agar plus starch, (*g*) mycelium on oat agar, (*a-b*) from cultures 2 weeks old, and (*c-g*) grom cultures 4 weeks old.

Syn. *Fusarium aridum* Pratt ; *F. Delacroixii* Sacc.
F. fraxini All. ; *F. discolor* App. et Wr.
F. discolor App. et Wr. v. *triseptatum* Sherb.
F. granulare Kalch. ; *F. herbarum* (Cda.) Fr. v. *conii-maculati* Roum. pr. p.
F. hordei (W. G. Sm.) Sacc. ; *F. maydis* Kalch.
F. pannosum Mass. ; *F. pulvinatum* (Berk. et Br.) Sacc.
F. ricini (Bér.) Bizz. ; *F. roseum* Link. pr. p.
F. sambucinum v. *medium* Wr. ; *F. subcarneum* Crouan.
F. tenellum Sacc. et Briard ; *F. tenuissimum* (Peck) Sacc.
Microcera tasmanica McAlp. ; *Discofusarium tasmaniense* Petch.
Pionnotes vagans Speg. ; *Fusarium violaceum* Crouan (non Fuck.).

Conidia fusiform-falcate, curved, somewhat abruptly bent inwards at both ends, constricted or conical at the apex, pedicellate at the base, thick-walled. Macroconidia borne on the aerial mycelium are sometimes mixed with 0-septate, subnormal conidia of different form. Aerial mycelium at first white, then golden yellow or pink. Macroconidia in sporodochia and pionnotes pink to salmon and orange red in mass, sometimes carmine red to chestnut brown or ochre by absorption of the colour of the plectenchymatous or sclerotially erumpent stroma. Conidia 3–5-, seldom 6–7-septate.

3-septate............	16–40 × 3–6.........	Mostly 23–33 × 3·5–5·2.
5-septate............	22–55 × 3·5–6.......	Mostly 26–42 × 3·8–5·6.
7-septate............	35–56 × 3·7–6.......	Average 42 × 5·2.

The sclerotial stroma often breaks out in rough, cauliflower-like, stilboid bodies, which are up to 1 c.m high, and mostly dark brown in colour. Chlamydospores comparatively rare, intercalary, spherical, single, in chains or in clusters.

The ascus stage of *Fusarium sambucinum*, which has not been observed in South Africa, may be briefly characterised as follows :—

Gibberella pulicaris (Fr.) Sacc.

Saccardo, Michelia 1 : 43, 1877. Wollenweber, Fusarium-Monographie. 353–356, 1931 ; Fus. aut. del. 27–29. Wollenweber and Reinking, Die Fusarien, 76, 1935.
(For complete bibliography and synonymy, see Wollenweber, loc. cit.)

Perithecial spherical, 0·18–3 × 0·15–0·25 mm. (av. 0·26 × 0·24 mm.) diam., scattered or in groups, with bluntly conical apex ; later collapsing, umbilicate, verrucose, blue-black or yellow brown ; borne on a raised, round or elongated stroma of several millimetres extent. Asci club-shaped, 8- or 4-spored ; spores monostichous or more or less distichous, elongated-fusiform, straight or slightly curved, broadly rounded at both ends ; mostly 3-septate, less frequently 1–2- or 4–7-septate ; 3-septate spores 17–40 × 4–9, mostly 22–31 × 5·2–7.

The conidial form has been found in South Africa on several hosts :—

Hab. *Citrus sinensis* Osbeck, on fruit shewing stem end rot after 12 weeks in storage ; oranges from Sunday's River and Groot Drakenstein, Cape, and from White River, Zebediela and Rustenburg, Transvaal ; also from the air in the citrus packhouse, Zebediela, M.H. 28439.

Lycopersicum esculentum Mill., from rotting petioles of wilted plant, Gqaga, Transkei, M.H. 28421.

Lepidosaphes Gloveri, on mussel scale on citrus (associated with *Tetacrium rectisporum*) Chase Valley, Maritzburg, Natal (van der Plank) M.H. 28438.

Also isolated by du Plessis (13) from rotting potato tubers (*Solanum Tuberosum*) from Ceres, Cape.

This cosmopolitan species occurs as a saprophyte on decaying parts of plants. It may act as a weak parasite and cause fruit rot in stone fruits and cucurbits ; it also occurs on scale and other insects. The ascus stage has been found in Europe, America and Australia.

Growth on Standard Media.

Oat agar : Aerial mycelium scanty or moderate in amount, short, cobwebby. Growth in substratum venetian pink to deep rose pink, deepening to amaranth purple ; in the dryer parts of the medium, it may be amber yellow to mustard yellow. Pionnotes developed after 14 days, and were pale ochraceous salmon.

Hard potato agar : Aerial mycelium very sparse, white, cottony. Pionnotes developed in 7 to 14 days, and were light ochraceous salmon to ochraceous slamon.

Standard synthetic agar plus starch : Aerial mycelium sparse, short, cobwebby, white ; or absent. Growth in substratum deep rose pink to old rose and honey yellow in places ; the yellow colour disappeared after 4 weeks. Pionnotes light pinkish cinnamon to light ochraceous salmon, or taking up the colour of the stroma and becoming light coral red. In one tube, branched, erect, *Clavaria*-like sclerotial bodies developed at the base of the tube ; these were pale, and after some weeks, sporodochia developed on the tips of some of the branches.

Potato agar plus 5 *per cent. dextrose :* A moderate amount of aerial mycelium developed ; it was tomentose or cobwebby, white to deep pink or Indian lake and yellow ochre—the yellow colour chiefly in hyphae in contact with the glass. Growth in substratum amaranth purple, pomegranate purple and Bordeaux.

Potato plug : Aerial mycelium fairly vigorous, tomentose, white to deep rose pink. Growth on substratum pomegranate purple to Bordeaux. After some weeks, the growth sometimes became rather felt-like and wrinkled, and numerous flesh colour sporodochia developed.

Melilotus stem : Aerial mycelium vigorous, cobwebby to sericeo-tomentose, white, or tinged rose pink or naples yellow. Conidia were produced freely on the mycelium after 14 days, in mass light to pale ochraceous buff ; a few sporodochia developed after 8 weeks. In one set of cultures, there were groups of rugulose sclerotia after 8 weeks ; these were pale at first, becoming brown with age.

Bean pod : Pods covered with a moderate growth of mycelium, which is tomentose to sericeo-tomentose, white, or tinged coral pink to light coral red. Conidia forming freely in the mycelium were light ochraceous buff in mass.

Rice : Growth at first white and flesh pink, becoming olive ochre to honey yellow. After 8 weeks, the growth may still be yellow, or it may be deep vinaceous to wood brown, and the grains vandyke brown.

Measurements of Conidia.

Oat agar, culture 2 weeks old, conidia from pionnotes.

6-septate	Rare	37·5 × 4·7.
5-septate	5 per cent	32·5–45 × 4·4–5.
4-septate	6 ,,	27·5–35 × 3·75–5.
3-septate	88 ,,	20–40 × 3–4·4.
2-septate	0·5 ,,	
1-septate	0·5 ,,	

Melilotus stem, culture 2 weeks old, conidia from mycelium.

6–7-septate	Rare	50 × 5.
5-septate	40 per cent	40–50 × 3·75–5.
4-septate	21 ,,	22·5–45 × 3·75–5.
3-septate	39 ,,	25–37·5 × 3·75–5.

Hard potato agar, culture 4 weeks old, conidia from sporodochia.

5-septate	3 per cent	32·5–40 × 4·7–5.
4-septate	4 ,,	27·5–32·5 × 4·7–5.
3-septate	76 ,,	20–35 × 3·75–5.
2-septate	12 ,,	
1-septate	5 ,,	

Potato plug, culture 8 weeks old, conidia from sporodochia.

4-septate............	Few..................	27·5 × 5.
3-septate............	85 per cent...........	16–40 × 3·75–5.
2-septate............	7 ,,	
1-septate............	8 ,,	

Bean pod, culture 2 weeks old, conidia from pionnotes.

6-septate............	Few..................	47·5–54 × 5.
5-septate............	57 per cent...........	32·5–52·5 × 3·75–5.
4-septate............	11 ,, ...	27·5–35 × 3–3·75.
3-septate............	30 ,, ...	20–21·25 × 3–3·75.
1-septate............	2 ,,	

Fusarium sambucinum Fuck. **f. 2.** Wr.

Wollenweber, Fusarium-Monographie, 357, 1931; Fus. aut. del. 611, 942, 1145. Wollenweber and Reinking, Die Fusarien, 77, 1935.

Syn. *Fusarium subpallidum* v. *roseum* Sherb.

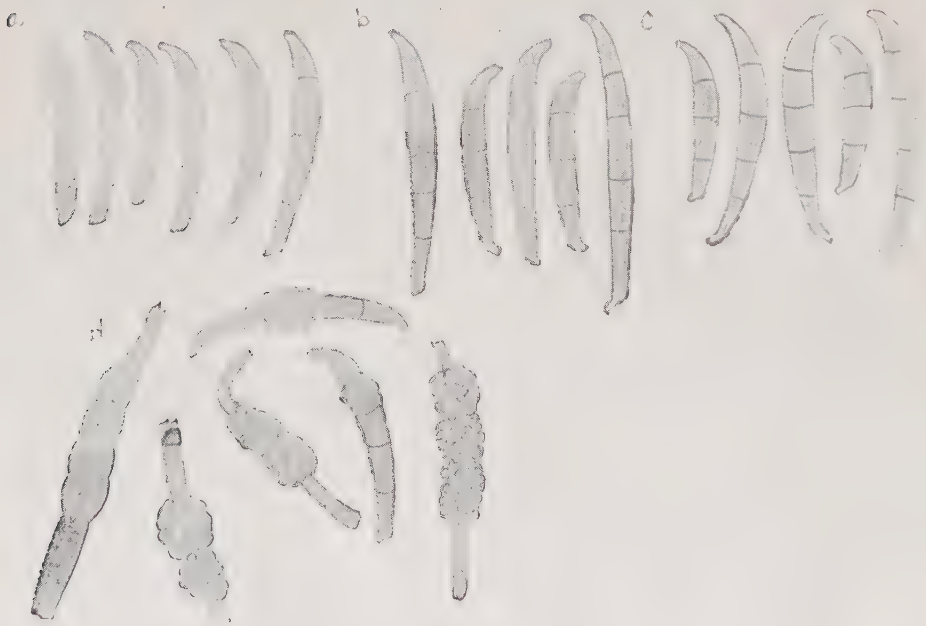

FIG. 16.

Fusarium sambucinum Fuck. *f.*2 Wr.; Conidia from sporodochia of 4 weeks old cultures on (*a*) oat agar, (*b*) bean pod, and (*c*) Melilotus stem, (*d*) chlamydospores from 4 weeks old culture on hard potato agar.

This variety is comparatively pale; aerial mycelium pale, yellowish or pink; stroma not carmine, pale or pinkish, does not become blue. Conidia in sporodochia or pionnotest pink to light orange-red or ochre in mass, and mostly 3-septate, 25 × 4·9, less frequently 4–5-septate; 5-septate conidia about 30 × 3.

Hab. *Citrus sinensis* Osbeck, from fruit shewing stem end rot after 18 weeks in storage; fruit from Groot Drakenstein, Cape, M.H. 28350 and 28357; Rustenburg, Transvaal, M.H. 28355; White River, Transvaal.

Lepidosaphes Gloveri, on mussel scale on *Citrus* (associated with *Tetacrium rectisporum*), Chase Valley, Maritzburg, Natal (van der Plank) M.H. 28415.

This variety has been found in Europe and North America, on diseased parts of plants of the genera *Citrus*, *Hordeum*, *Lycopersicum*, *Rubus* and *Solanum*; it is also found on mussel scale and in the soil.

Growth on Standard Media.

Oat agar: Aerial mycelium sparse or moderate in amount, fine, white, cottony. Growth in substratum colourless, or becoming tinged with congo pink near the base of the slant after 4 weeks. Small, scattered sclerotial bodies were tilleul buff, and became brownish. Sporodochia developed in 2 to 4 weeks; they were light ochraceous salmon.

Hard potato agar: Aerial mycelium white; it may be short and sparse, or vigorous, cottony. Growth on substratum colourless. Pionnotes and sporodochia developed in 2 to 4 weeks; they were light ochraceous salmon.

Standard synthetic agar plus starch: Aerial mycelium scant, fine, white, cottony, or absent. Growth in substratum colourless, or faintly pink; sometimes there was a tinge of brown near the base of the slant. The agar was often stained coral pink. Pionnotes and sporodochia, developing after 14 days, were light ochraceous salmon.

Potato agar plus 5 per cent. dextrose: Aerial mycelium copious or sparse, fine, white, cottony to tomentose. Growth in substratum avellanous, pale flesh colour, congo pink, or brownish vinaceous to deep brownish vinaceous; it sometimes became wrinkled and felt-like, and sometimes there were masses of brown plectenchyma at the base of the slant. A few scattered sporodochia sometimes developed.

Potato plug: Plug covered with a dense growth of fine, white, cottony mycelium; light brown, raised masses of plectenchyma (up to 4 mm. diameter) sometimes developed from the stroma. Sporodochia often numerous, crowded, light ochraceous buff to light ochraceous salmon.

Melilotus stem: Mycelium white, or tinged ochre, cottony to sericeo-tomentose, vigorous or sparse. Numerous sporodochia developed; they were 0·5 to 3 mm. in diameter, single or in groups, light ochraceous buff to light ochraceous salmon.

Bean pod: Aerial mycelium white, cottony to tomentose, vigorous or sparse. Small masses of brown plectenchyma sometimes developed between the medium and the glass. Large groups of sporodochia developed after 14 days; they were light ochraceous buff to ochraceous salmon.

Rice: Growth white to flesh colour; grains naples yellow. The pink colour faded with age, and the grains often became brown.

Measurements of Conidia.

A.—Strain from oranges.

Oat agar, culture 2 weeks old, conidia from sporodochia:—

5-septate	Few	35 × 5.
4-septate	1 per cent	30–32·5 × 3·75–4·4.
3-septate	96 ,,	20–37·5 × 2·8–4·7.
2-septate	3 ,,	

Melilotus stem, culture 2 weeks old, conidia from sporodochia.

3-septate	99 per cent	20–35 × 3·75.
2-septate	1 ,,	

Bean pod, culture 2 weeks old, conidia from sporodochia.

4-septate	3 per cent	32·5–42·5 × 3·75.
3-septate	96 ,,	22·5–45 × 2·8–4·4.
1-septate	1 ,,	

B.—Strain from mussel scale.

Oat agar, culture 4 weeks old, conidia from sporodochia:—

5-septate	86 per cent	25–42·5 × 4·7–5.
4-septate	11 ,,	22·5–32·5 × 3·7–5.
3-septate	3 ,,	17·5–40 × 4·7–5.

Hard potato agar, culture 4 weeks old, conidia from sporodochia.

5-septate............	23 per cent..........	25–32·5 × 3·75–5.
4-septate............	64 ,, ...	22·5–30 × 3·75–4·7.
3-septate............	13 ,, ...	18·75–30 × 3·75–4·7.

In cultures of the strain from mussel scale, 5-septate conidia were more frequent, and the conidia, on the whole, stouter than in cultures of this variety from oranges.

Fusarium sambucinum Fuck. **f. 6** Wr.

Wollenweber, Fusarium-Monographie, 358, 1931 ; Fus. aut. del. 327–329. Wollenweber and Reinking, Die Fusarien, 78, 1935.

Syn. *Fusarium sulphureum* Schlecht.

F. discolor App. et Wr. v. *sulphureum* (Schl.) App. et Wr.

F. genevense Daszewska.

This variety is distinguished by the sulphur yellow colour of the plectenchymatous part of the stroma and the aerial mycelium, and the absence of the carmine colouring found in the species and the other varieties. Spherical, dark blue sclerotia may be present or wanting. Conidia in sporodochia and pionnotes, light orange in mass. Sclerotial plectenchyma light brown to sepia. Chlamydospores intercalary, conidia 3–5-septate ; 3-septate 28 × 4·5 ; 5-septate 38 × 5·1.

This form was not observed in the Union, but is recorded by Wollenweber (loc. cit.) as occurring in South West Africa on the red locust, *Nomadacris septemfasciata*.

Form 6 is cosmopolitan, and occurs on a large number of plants, and also on mushrooms, in soil, etc. It causes a tuber rot of potatoes.

Fusarium culmorum (W. G. Sm.) Sacc.

Saccardo, Syll. Fung. 11, 651, 1895. Wollenweber, Fusarium-Monographie, 360, 1931 ; Fus. aut. del. 330-337, 613, 943–945, 1147–1149. Wollenweber and Reinking, Die Fusarien, 79–81, 1935.

Syn. *Fusisporium culmorum* W. G. Sm. ; *Fusarium culmorum* (W. G. Sm.) Sacc. *f. 1.* Wr.

Fusarium culmorum (W. G. Sm.) Sacc. v. *leteius* (*-lethaeum*) Sherb.

F. culmorum (W. G. Sm.) Sacc. v. *majus* Wr. (nom. nud.).

F. heidelbergense Sacc. ; *F. mucronatum* Fautr. in herb. pr. p.

F. neglectum Jacz. ; *F. roseum* Lk. v. *rhei* Karst.

F. rubiginosum App. et Wr. ; *F. sambucinum* Fuck. *f. 3.* Wr.

F. Schribauxii Del. ; *Fusoma tenue* Grove.

Fusarium versicolor Sacc.

Conidia at first scattered in the aerial mycelium, free or in false heads, later sometime forming a pionnotal layer, or covering the tubercularia-like sporodochia. Conidia in mas varied in colour, yellow, pink, later ochre to coffee brown, often becoming more or less tinged with the colour of the stroma. Stroma purple-red and golden yellow to ochre brown. Conidia fusiform-falcate, gradually or abruptly attenuate at both ends ; apical cell sometimes rostrate, constricted like the neck of a bottle ; base pedicellate ; wall thick, highly refractive, often brownish ; septations distinct. Conidia 5-septate, less frequently 3–4- or 6–8-septate ; exceptionally less than 3-septate.

3-septate..............	19–40 × 4–7·6, ...mostly	24–32 × 4·8–7.
5-septate..............	23–74 × 4–8·8, ...mostly	30–60 × 4·8–7·5.
7-septate..............	36–75 × 4–9, ...mostly	42–54 × 5–8.

Chlamydospores more frequently intercalary than terminal, spherical or oval, occurring in conidia as well as in the mycelium, single, 2-celled, or in chains and clusters, brown in mass, 1-celled 9–14 μ diam., 2-celled 13–27 × 7–19 μ.

Hab. *Lolium temulentum* L., from stems of plants affected with foot rot (ass. *Helminthosporium* Sp.), Waaikraal, Pretoria dist. (Wager).

Sorghum vulgare Pers. v. *caffrorum* (Thun.) Hubb. et Rehder, forming a pink incrustation on heads of kaffir corn infected with smut, (*Sphacelotheca sorghi*), Ixopo, Natal, May 1923 (Storey) M. H. 17272.

Triticum sp., from stems of plants affected with foot rot, (ass. *Helminthosporium* sp.), Waaikraal, Pretoria dist., (Wager).

This species, which is widely distributed, is injurious to cereals, and may cause a rot of stored fruits. It occurs on numerous genera of plants, in the soil, in the air, and on other fungi.

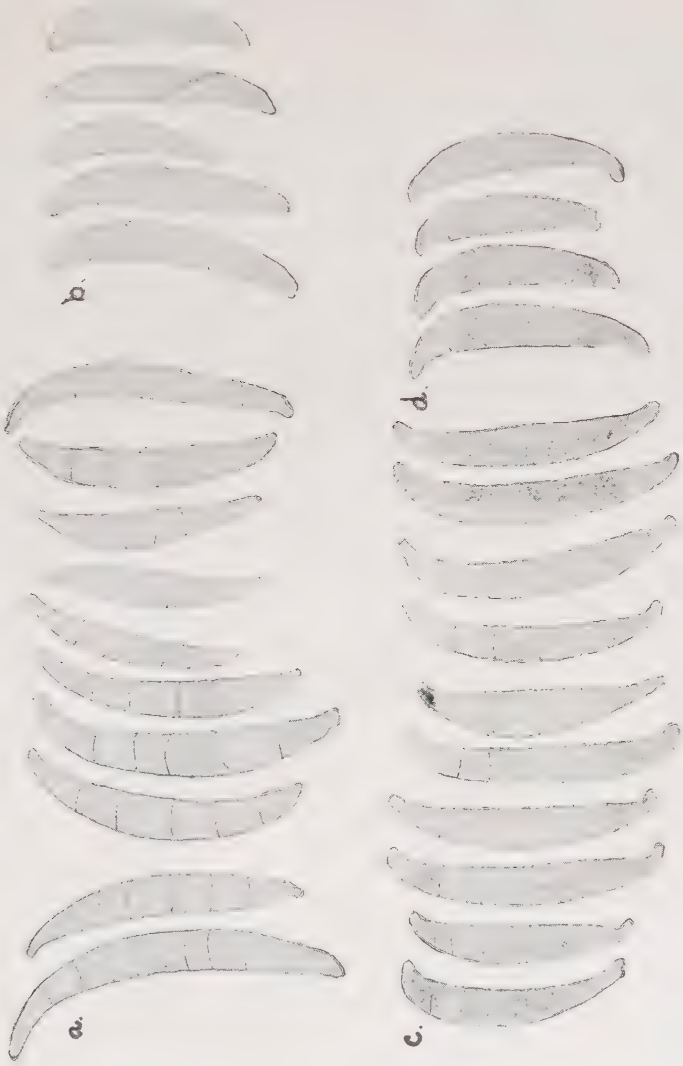

Fig. 17.

Fusarium culmorum (W. G. Sm.) Sacc.; conidia from (*a*) pink incrustation on *Sorghum* (M.H. 17272), (*b*) pionnotes of 4 weeks old culture on bean pod; from mycelium of 2 weeks old cultures of (*c*) standard synthetic agar plus starch and (*d*) on potato agar.

Growth on standard media.

Oat agar : Aerial mycelium copious, cottony, white to ochraceous buff and honey yellow, or tinged pink. Growth on substratum carmine to ox-blood red. A few large sporodochia developed after 4 weeks; they were light ochraceous salmon.

Hard potato agar: Aerial mycelium scant, white, tufted. Growth in substratum colourless; after 14 days, the slant was covered with a thin pionnotal layer, which was light ochraceous salmon to vinaceous cinnamon. A few small sporodochia were ochracous salmon to orange cinnamon.

Standard synthetic agar plus starch: Aerial mycelium scant to moderate in amount white. Growth on substratum tyrian rose to pomegranate purple, carmine and ox-blood red. Numerous small sporodochia and pionnotes were light ochraceous salmon and salmon buff to vinaceous cinnamon.

Potato agar plus 5 *per cent. dextrose:* Aerial mycelium at first white, then white to chamois colour at the top of the slant, below stained begonia rose. Growth on substratum carmine to ox-blood red. Spore masses were tinged with the red colour of the stroma.

Potato plug: Aerial mycelium copious, rather coarse, cobwebby, white to naples yelow and rose pink. Growth on substratum eugenia red to ox-blood red.

Melilotus stem: Stems covered with a vigorous growth, white at the top where the mycelium filled the tube; below clothing the stems with a growth chatenay pink to spinal red in colour. Sporodochia not numerous, light ochraceous salmon.

Bean pod: Growth extremely vigorous, the whole tube being filled with mycelium which was white to geranium pink. Extensive pionnotes developed, which were at first ochraceous salmon and later vinaceous cinnamon.

Rice: Aerial mycelium copious, at first white to amber yellow, later becoming white to ochre red. Growth on substratum alizarine pink to acajou red, becoming pompeian red to madder brown.

Measurements of conidia.

Standard synthetic agar plus starch, culture 14 days old, conidia from sporodochia.		
7-septate	4 per cent	42·5–45 × 5–6·3.
6-septate	2 ,, ...	40–42·5 × 6–6·3.
5-septate	86 ,, ...	30–47 × 5–7.
4-septate	6·5 ,, ...	28–35 × 5–7.
3-septate	1·5 ,, ...	27–36 × 4–5.
Oat agar, culture 4 weeks old, conidia from sporodochia.		
6-septate	3 per cent..........	45–50 × 5–6.
5-septate	59 ,, ...	37·5–53 × 5–6.
4-septate	21 ,, ...	35–52·5 × 5–6.
3-septate	17 ,, ...	30–37·5 × 5.
Melilotus stem, culture 16 days old, conidia from sporodochia.		
7-septate	0·5 per cent........	45 × 6.
6-septate	3·5 ,, ...	40–45 × 5·5–6·3.
5-septate	64 ,, ...	30–45 × 5–6·3.
4-septate	16 ,, ...	27·5–37·5 × 5–6·3.
3-septate	16 ,, ...	20–35 × 5–6·3.
From pionnotes occurring in nature on ovaries of *Sorghum*, M. H. 17272.		
9-septate	Rare.................	55 × 6·3.
7-septate	1·5 per cent........	40–45 × 6.
6-septate	6·5 ,, ...	40–47·5 × 6–6·3.
5-septate	79 ,, ...	35–45 × 5–6·3.
4-septate	6·5 ,, ...	27·5–35 × 5–6.
3-septate	6·5 ,, ...	27·5–32·5 × 4–6.

Fusarium graminearum Schwabe.

Schwabe, Fl. Anhaltina, 2 : 285, 1838. Wollenweber, Fusarium-Monographie, 363, 1931 ; Fus. aut . del. 338, 339, 354–357, 948. Wollenweber and Reinking, Die Fusarien, 82–83, 1935.

Syn. *Fusarium graminearum* Schw. v. *caricis* (Oud.) Wr.

F. caricis Oud.; *Pionnotes flavicans* Sacc. et D. Sacc.

?*Selenosporium bufonicola* Speg.; *Fusarium bufonicola* (Speg.) Sacc. et Trott.
Fusarium discolor App. et Wr. v. *majus* Wr. *apud* Lewis (nom. nud.).
F. fimicolum Tassi; *F. gynerii* Cke. et Hark.
F. Mollerianum Thuem.; *F. insidiosum* (Berk.) Sacc.
?*F. rhoicolum* Fautr.; *F. roseum* Lk. pr. p.; *Fusidium roseum* Lk. pr. p.
F. roseum Lk. v. *maydis* Sacc.; ?*F. roseum* Lk. v. *cucubali-bacciferi* Sacc.
F. rostratum App. et Wr. (non Speg.) *F. stictoides* Dur. et Mont.

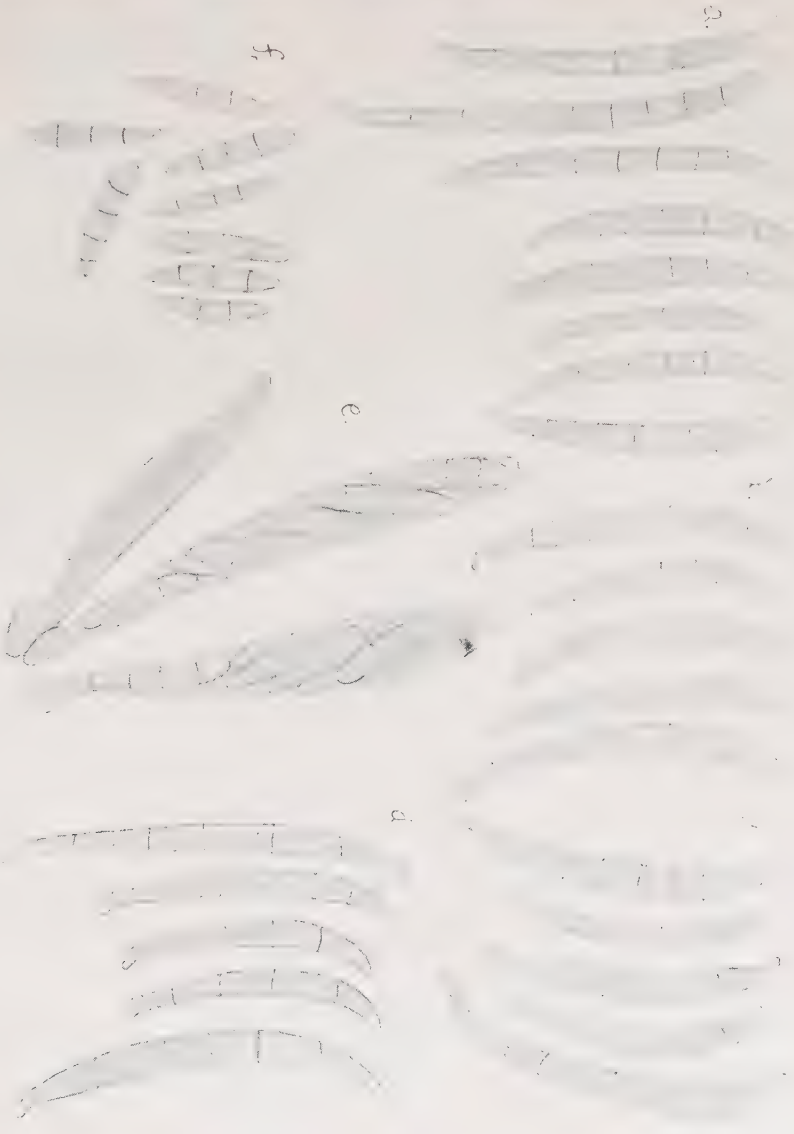

Fig. 18.

Fusarium gramineaerum Schwabe; conidia from mycelium of culture on (*a*) oat agar, 4 weeks old, (*b* and *d*) potato plug, 7 weeks old, (*c*) standard synthetic agar plus starch, 5 weeks old, (*e-f*) *Gibberella Saubinetii* (Mont.) Sacc., (*e*) asci and (*f*) sporidia.

Aerial mycelium floccose, white or tinged with pink or yellow. Stroma varied in colour, white to pink, golden yellow, ochre, or carmine to purple red ; it is partly plectenchymatous, effuse, more or less covered with floccose mycelium, and partly sclerotially erumpent and clothed with conidial masses. These are less frequently sporodochial than pionnotal, and are ochre to light orange red. Conidia sometimes compact, as in *F. culmorum*, sometimes more elongated, fusiform-falcate, curved, tapering at both ends ; apex conical or constricted ; base pedicellate. Conidia 3–5-septate, less frequently 1–2- or 6–9-septate.

3-septate..............	25–66 × 3–6	mostly	30–47 × 3·3–5.
5-septate..............	28–72 × 3·2–6	mostly	41–60 × 4·3–5·5.
7-septate..............	50–88 × 4–7	mostly	61–82 × 4·5–6·5.
9-septate..............	55–106 × 4–8	mostly	61–96 × 4·5–7.

Chlamydospores wanting or scarce, intercalary.

Hab. *Zea Mays* L., on grain and cob, (grain germinating on the cob), L'Orange, Louis Trichardt, N. Transvaal, Oct. 1932 (Leemann) M.H. 28442 and 26582; on grain and cob showing moulding and pink discolouration, Rustenburg, Aug. 1929 (Watts) M.H. 24866 ; from maize meal, Bethal, O.F.S. ; from grain (which frequently showed no sign of disease), Kenya, 1930 (Macdonald).

The conidial stage was also isolated from maize stalks on which *Gibberella* fructifications had developed.

Fusarium graminearum is cosmopolitan and it occurs chiefly on cereals, to which it is injurious, causing foot rot and seedling blight ; it also causes cob mould of maize. It is the conidial form of :—

Gibberella Saubinetii (Mont.) Sacc. pr. p.

(For synonymy and bibliography, see Wollenweber loc. cit.)

Perithecia blue-black, solitary or in groups, verrucose or smooth, ovoid or spherical, coriaceo-membranaceous, frequently crowned at the apex with a long-celled outgrowth of the peridium, 0·20 × 0·17 (0·15–0·3 × 0·1–0·25) mm. (Plate II b.) Ascus 8-spored, 37–84 × 8–15, club-shaped. Spores monostichous or imperfectly distichous, fusiform, slightly curved or almost straight, broadly conical to acute at both ends, 3-septate, 16–33 × 3–6, mostly 18–27 × 3·4–5, less frequently 1-septate, 14–24 × 2·5–5, exceptionally 4-septate.

Hab. *Zea Mays*, on stalks, Kenya, March 1930 (MacDonald) M.H. 25348 ; Hopevale, nr. Donnybrook, Natal, Jan. 1935 (Doidge) M.H. 27723.

Growth on Standard Media.

Oat agar : Aerial mycelium fairly abundant, tufted, cottony, white to yellow ochre and rose colour. Growth on substratum pomegranate purple to Bordeaux. After 4 weeks, the ochre colour disappeared. No spore masses were observed.

Hard potato agar : Aerial mycelium fairly well developed, or scant, cottony, white to rose pink. Growth in substratum colourless, or with a tinge of Bordeaux.

Standard synthetic agar plus starch : Aerial mycelium scanty, white to yellow ochre. Growth in substratum eugenia red to carmine.

Potato agar plus 5 per cent. dextrose : Slant covered with a fairly vigorous mycelial growth, which was floccose, white to rose colour or yellow ochre. Growth in substratum pomegranate purple to Bordeaux. The ochre colour disappeared with age.

Potato plug : Plug covered with a cottony, tufted mycelium, which is often very vigorous. It is white to rose pink and ochre. Growth in substratum carmine, pomegranate purple, Bordeaux or ox-blood red.

Melilotus stem : Stems covered with a vigorous mycelial growth, which was cottony at first, and white to rose pink or ochre ; later the colour in some tubes deepened to carmine, and the yellow colour faded.

Bean pod : Aerial mycelium vigorous, covering pods, at first white to rose colour and yellow ochre. Later the growth was white to Bordeaux, and the yellow colour had faded.

Rice : Aerial mycelium white to naples yellow and yellow ochre ; growth on grains honey yellow, or carmine to ox-blood red. In 4-6 weeks the colour faded, and growth was cinnamon buff to snuff brown.

Measurements of conidia.

Hard potato agar, culture 4 weeks old, conidia from mycelium.		
6–7-septate............	Few.................	52·5–62·5 × 5.
5-septate............	59 ,, ...	37·5–65 × 4·4–5.
4-septate............	22 per cent..........	30–57·5 × 3–5.
3-septate............	19 ,, ...	22·5–47·5 × 3–5.
Oat agar, culture 4 weeks old, conidia from mycelium.		
8-septate............	2 per cent..........	67·5–89 × 4·4–5.
7-septate............	2 ,, ...	70–89 × 3·75–5.
6-septate............	10 ,, ...	57·5–72·5 × 4–4·7.
5-septate............	36 ,, ...	40–65 × 4–4·7.
4-septate............	13 ,, ...	37·5–50 × 3–4·4.
3-septate............	25 ,, ...	22·5–42·5 × 3–3·75.
2-septate............	2 ,,	
1-septate............	10 ,,	
Standard synthetic agar plus starch, culture 3 months old, conidia from mycelium.		
7–8-septate............	Rare................	50–65 × 4·7–5·5.
6-septate............	1 per cent..........	45–65 × 4–5·5.
5-septate............	61 ,, ...	30–54 × 4·4–5.
4-septate............	36 ,, ...	30–42·5 × 3·7–4·7.
3-septate............	2 ,, ...	20–45 × 3·75–5.

Section LATERITIUM.

Wollenweber, Ann. myc. 15 : 2 and 54, 1917 ; Fusarium-Monographie, 368–370, 1931. Wollenweber and Reinking, Die Fusarien, 86–88, 1935.

Mycelium white, pink, yellow, orange, violet to blue-black. Stroma pale or carmine to ochre, green olive, brown or blue-black. Spherical sclerotia dark blue or pale. Microconidia 0–1- or more septate, rare, usually small, ellipsoid or comma-shaped, or large, thick-walled, ovoid to pyriform, disappearing with the formation of sporodochia and pionnotes. Macroconidia long, cylindrical, fusiform to lanceolate, almost straight to falcate, constricted at the apex, and more curved near the apex than in the middle, base pedicellate. Macroconidia pink, and orange to brick red in mass, sometimes becoming darker through absorption of the colour of the stroma, or becoming lighter if dry and powdery. Terminal chlamydospores wanting : intercalary chlamydospores occur more or less frequently in conidia and mycelium.

Key to the South African Species.

A.—Conidia in sporodochia and pionnotes 3–5-septate........ *F. lateritium.*
AA.—Conidia in sporodochia and pionnotes 5-septate :
B.—Stroma not carmine to ochre..................... *F. lateritium* v. *longum.*
BB.—Stroma carmine to ochre........................ *F. stilboides.*

Fusarium lateritium Nees.

Nees, System d. Pilze u. Schwamme, 31, 1817. Wollenweber, Fusarium-Monographie, 370–375 1931 ; Fus. aut. del. 226, 228–276, 281–285, 570, 577–581, 583–587, 592, 955–957, 959–961, 1154. Wollenweber and Reinking, Die Fusarien, 88–91, 1935.

Syn. *Fusarium lateritium* Nees *f.* 1. Wr., and v. *pallens* Wr.
F. lateritium Nees v. *fructigenum* Wr. and *f.* 1 *and f.* 2 *Wr.*
F. lateritium Nees v. *tenue* Wr.; *F. acaciae* Cke. et Harkn.
F. fructigenum Fr.; *F. limonis* (Briosi) Penz.
(For complete bibliography and very extensive synonymy, see Wollenweber, loc. cit.).

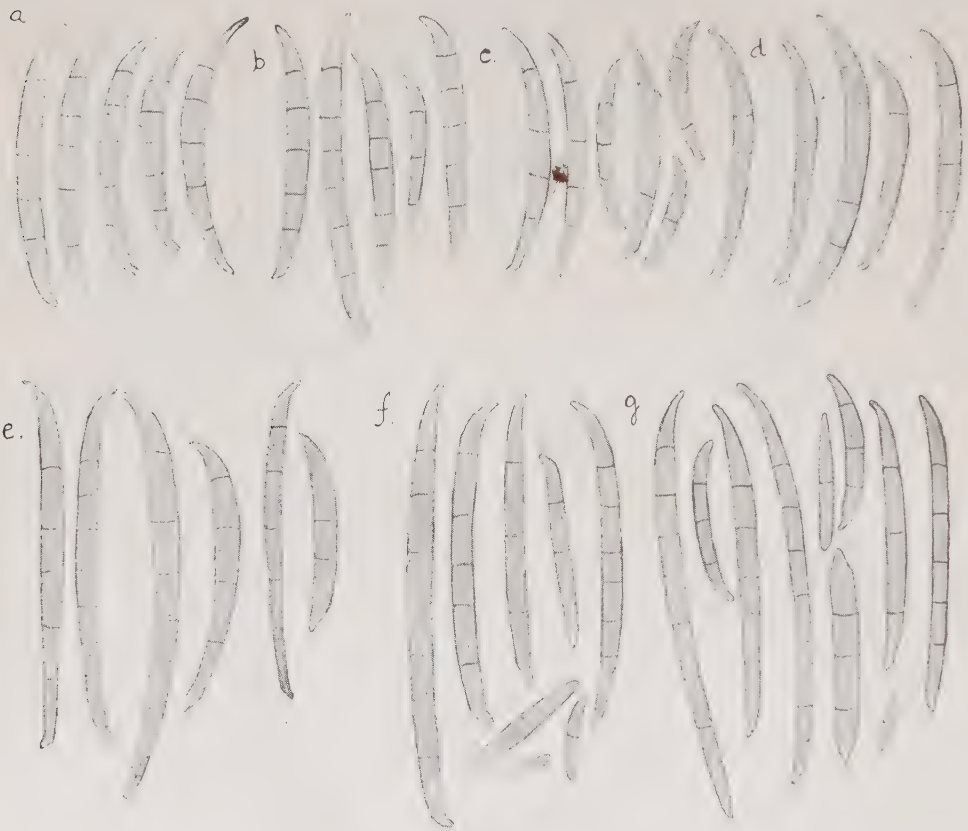

Fig. 19.

Fusarium lateritium Nees; (*a-d*) strain from failing citrus buds, (*e-g*) from citrus twig; conidia from pionnotes of (*a*) 5 weeks old culture on Melilotus stem, (*b*) 10 weeks old culture on potato plug, (*c*) 2 weeks old culture on oat agar: conidia from (*d*) pionnotes of 8 weeks old culture on synthetic agar plus starch, (*e*) mycelium on bean pod, culture 4 weeks old; pionnotes of 4 weeks old culture on (*f*) standard synthetic agar plus starch and (*g*) oat agar.

Stroma fleshy, erumpent, smooth, convex; or cartilaginous, sclerotial, plectenchymatous rough (cauliflower-like); or erect and branched; pale pink, yellow, orange, or chestnut brown to dark blue; sometimes with spherical sclerotia, which are dark blue to pale. Aerial mycelium pale, pink or yellow, or tinged with the colour of the plectenchymatous stroma. Conidia at first scattered in the mycelium; later sporodochia develop, singly or in groups; they often coalesce to form a continuous pionnotal layer. Conidia in mass brick red to orange, golden yellow, pink, or salmon colour. Conidia 3–5-septate, rarely with fewer or more septations, thin-walled, long, fusiform-falcate, almost cylindrical, or slightly dorsiventral in the middle, definitely curved and often abruptly bent near the apex; apex constricted, sometimes rostrate; base typically pedicellate.

0-septate............	7-$11 \times 2{\cdot}5$ $3{\cdot}5$......	Average $7{\cdot}8 \times 2{\cdot}8$.
1-septate............	11–35×2–5.........	Mostly 13–$30 \times 2{\cdot}4$–$4{\cdot}5$.
3-septate............	13–52×2–5.........	Mostly 2 1–$42 \times 2{\cdot}5$–$4{\cdot}4$.
5-septate............	24–$84 \times 2{\cdot}5$–5......	Mostly30–59 $\times 3{\cdot}2$–$4{\cdot}7$.
7-septate............	32 84×3–5.........	Mostly 49–$72 \times 3{\cdot}3$–$4{\cdot}5$.

Chlamydospores rare, intercalary, in conidia and mycelium. Sclerotial plectenchyma up to 5 mm. thick, blue, brownish or colourless.

The ascus stage which has not been observed in South Africa is :—

Gibberella baccata (Wallr.) Sacc.

(For extensive bibliography and synonymy, see Wollenweber loc. cit.).

Perithecia often interspersed with the sporodochia of the conidial stage, or in groups, blue-black, obovate to spherical, rugulose, papillate at the apex, with an inconspicuous ostiole and a delicate plectenchymatous wall, $0{\cdot}2$–$0{\cdot}3 \times 0{\cdot}15$–$0{\cdot}22$ mm. Asci 8-spored, seldom 4-spored, club-shaped, delicate, pedicellate, paraphysate. Spores hyaline, smooth, oblong-ovoid or fusiform, broadly conical at both ends, sometimes sub-dorsiventral, 3 (1–3) -septate ; 3-septate spores 12–30×4–10, mostly 13–$25 \times 4{\cdot}7$–$8\ \mu$.

The ascus stage has been found on a number of hosts in Europe, America, Asia and Australia. The conidial stage is cosmopolitan, occurring chiefly in the temperate zone on a large number of hosts ; it is a cause of bud rot, fruit rot and die back of twigs. It has been found on *Citrus* and several other hosts in South Africa.

Hab. *Carica papaya* L., on decaying pawpaw fruit (a secondary form of decay associated with *Gloeosporium* sp.) Bokfontein, Pretoria Dist., M.H. 28429.

Citrus limonia Osbeck, from stem end rot of lemon, developing after 18 weeks in storage ; fruit from Rustenburg, Transvaal.

Citrus sinensis Osbeck, from fruit (75 strains studied), common in fruit shewing stem end rot (78 per cent.) and navel end rot or lateral lesions after 6–7, or 12–18 weeks in storage, 1933–34 ; in navel oranges from Muden, Natal, from Rustenburg, White River, Letaba and Zebediela, Transvaal, and from Sunday's River, Cape ; from tough, dry form of rot on side of navel orange from Zebediela, 1931, M.H. 28395.

From twigs showing die-back, Hankey, Cape, May 1930 (van der Plank) M.H. 28423 ; Ofcalaco, N. Transvaal, July 1930 (van der Plank).

From bark, scaling off orange trees after prolonged drought, De Wildt, Pretoria Dist., March 1934 (Doidge) ; on bark cracking and gumming, probably as a result of root injury, Elandshoek, E. Transvaal (Simmonds) ; on bark of tree affected by scaly bark, Mazoe Estates, S. Rhodesia (Bates).

On buds in nursery stock, failing under wet conditions, White River, E. Transvaal, Nov. 1929 (Esselen).

Euphorbia crassipes Marloth, on rotting stem of succulent *Euphorbia*, Willeston, Cape, M.H. 28378 and 28391.

Prunus persica Sieb. et Zucc., on decaying fruit, Orchard Siding, Cape, Feb. 1913 (Dicey) M.H. 5637.

Lepidosaphes Gloveri (associated with *Tetacrium rectisporium*) on mussel scale on *Citrus* twigs, Case Valley, Maritzburg, Natal (van der Plank) M.H. 28391.

Ceroplastis sp., from large waxy scale, on twigs of Acacia sp., Grahamstown, Cape (Smith) M.H. 28443.

Growth on Standard Media.

Oat agar : Aerial mycelium very sparse, fine, white, cottony. Growth in substratum at first colourless to barium yellow ; later it often became olive ochre to brown, or, especially near the base of the slant, dark delft blue and sclerotially erumpent. In some cultures there were a few small, dark blue, spherical sclerotia. Pionnotes developed freely ; they were pale flesh colour to light ochraceous salmon, later becoming flesh ochre to rufous.

Hard potato agar : Aerial mycelium sparse, short, white, sometimes becoming mealy-looking, when conidia are formed in minute masses. Growth in substratum colourless, or with a faint touch of pink. Numerous minute sporodochia rapidly coalesced to form a continuous pionnotal layer, which was at first pale flesh colour to light ochraceous salmon, then bittersweet orange ; the last named colour soon faded to flesh ochre.

Standard synthetic agar plus starch : Aerial mycelium sparse to moderate in amount, white, cobwebby. Growth in substratum at first colourless, remaining pale and becoming raised and gelatinous, or becoming deep delft blue and sclerotially erumpent near the base of the slant. Pionnotes developed freely and were light ochraceous salmon to bittersweet pink.

Potato agar plus 5 *per cent. dextrose :* Aerial mycelium wanting, sparse, or moderate in amount, cottony or tomentose, white tinged naphthalene yellow and buff pink, sometimes becoming deep olive buff. Growth on substratum at first pale to flesh pink and pinkish cinnamon, raised and somewhat gelatinous in places ; the stroma remained pale, or became light brownish olive to snuff brown, bister, or slate colour to blue-black. The medium sometimes became stained brown or black. Pionnotes developed freely, and were ochraceous salmon, bittersweet pink to grenadine pink and flesh ochre.

Potato plug : Plug usually covered with a moderate amount of aerial mycelium ; this was fine, cottony to felt-like or sericeo-tomentose, sometimes becoming mealy where conidia developed, white to cream buff and olive ochre. Pionnotes usually developed, and were ochraceous salmon to flesh ochre. Small sclerotia developed in some tubes.

Melilotus stem : Mycelium scanty or fairly, abundant, cottony to sericeo-tomentose, white to naphthalene yellow and ochre. Sporodochia developed ; they were flesh colour to flesh ochre. In some strains, groups of small blue-black sclerotia developed.

Bean pod : Pods covered with a moderate growth of white mycelium, which was cottony to sericeo-tomentose, or with a tough, leathery, wrinkled growth, tilleul buff in colour. Pionnotes and sporodochia usually developed ; they were flesh colour, salmon, bittersweet pink and salmon buff.

Rice : Growth white to flesh colour and grenadine pink to carrot red ; it may be naples yellow to mustard yellow in places. The colour may fade with age. Spore masses developed in some tubes.

Measurements of Conidia.

Bean pod, strain from *Citrus* twig, culture 4 weeks old, conidia from pionnotes.

8-septate............	1 per cent........	82·5 × 3·75.
6-septate............	2·5 ,, ...	57·5–70 × 3–3·75.
5-septate............	18 ,, ...	50–67·5 × 3–3·75.
4-septate............	11 ,, ...	50–65 × 3·75.
3-septate............	50·5 ,, ...	27·5–50 × 2·5–3·5.
1-septate............	18 ,,	

Bean, strain from pawpaw fruit, culture 2 weeks old, conidia from pionnotes.

6-septate............	0·5 per cent.	
5-septate............	75 ,, ...	35–47·5 × 3·7–4·5.
4-septate............	8 ,, ...	32·5–40 × 3·7–4.
3-septate............	15 ,, ...	22·5–35 × 3–4.
0-1-septate............	1·5 ,,	

Bean, strain from *Euphorbia* stem, culture 2 weeks old, conidia from pionnotes

8-septate............	Few................	65 × 3·75.
6-septate............	10 per cent..........	42·5–65 × 3·7–4·7.
5-septate............	67 ,, ...	42·5–65 × 3·7–4·7.
4-septate............	12 ,, ...	42·5–50 × 3·7–4.
3-septate............	8 ,, ...	22·5–40 × 3–3.75.
1-septate............	3 ,,	

Hard potato agar, strain from *Citrus* twig, culture 4 weeks old, conidia from pionnotes.

7-septate............	1	per cent........	$62 \cdot 5 – 67 \cdot 5 \times 3 \cdot 75$.
6-septate............	3·5	,, ...	$60 – 67 \cdot 5 \times 3 – 3 \cdot 75$.
5-septate............	22	,, ...	$52 \cdot 5 – 72 \cdot 5 \times 2 \cdot 5 – 3 \cdot 75$.
4-septate............	36	,, ...	$50 – 62 \cdot 5 \times 3 – 3 \cdot 5$.
3-septate............	25	,, ...	$30 – 45 \times 3 – 3 \cdot 5$.
2-septate............	1·5	,,	
1-septate............	9	,, ...	$17 \cdot 5 – 22 \cdot 5 \times 2 – 3$.
0-septate............	4	,,	

Fusarium lateritium Nees var. **longum** Wr.

Wollenweber, Fusarium-Monographie, 385, 1931; Fus. aut. del. 964, 965. Wollenweber and Reinking, Die Fusarien, 93, 1935.

Syn. *Fusarium lateritium* Nees v. *longum f.* 1 Wr.

Microcera mytilaspidis McAlp.

? *Fusarium longisporum* Cke. et Mass.

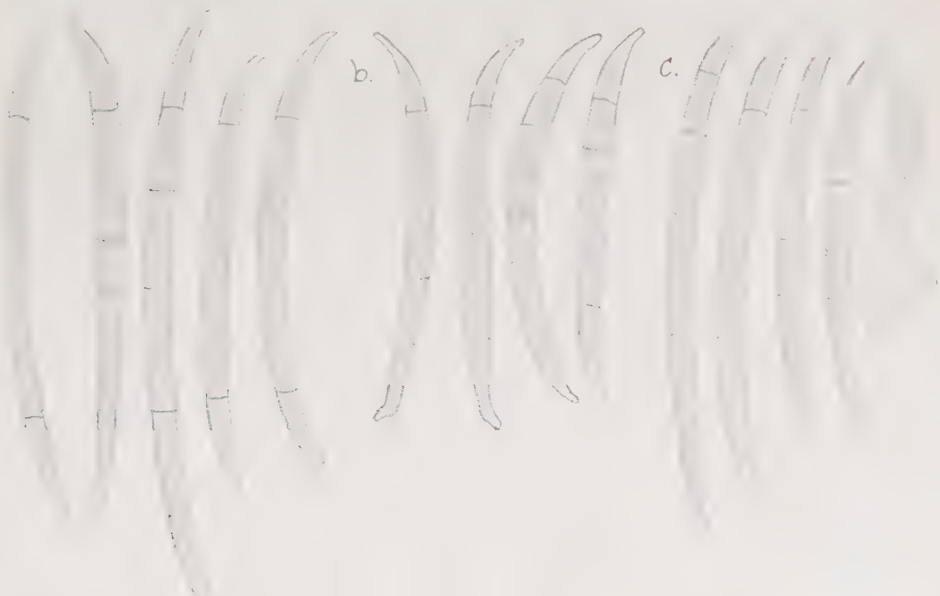

Fig. 20.

Fusarium lateritium Nees. v. *longum* Wr.; conidia from (*a*) sporodochia of 5 weeks old culture on standard synthetic agar plus starch, and (*b*) sporodochia of 2 weeks old culture on bean pod.

The conidia are long, cylindrical, tapering at both ends, constricted at the apex, pedicellate at the base; in sporodochial and pionnotal masses they are orange red. In the aerial mycelium, there are a few, small, scattered, 0–1-septate forms, but conidia are mostly 5-septate, less frequently 3–4- or 6–7-septate, exceptionally 9-septate.

0-septate............	$8 – 16 \times 2 – 3 \cdot 3$.......	Average $9 \times 2 \cdot 5$.
1-septate............	$9 – 20 \times 2 \cdot 5 – 3 \cdot 5$.....	Average 13×3.
3-septate............	$19 – 54 \times 3 – 4 \cdot 2$.......	Average $42 \times 3 \cdot 7$.
5-septate............	$45 – 80 \times 3 \cdot 5 – 5 \cdot 5$.....	Mostly $52 – 69 \times 3 \cdot 9 – 4 \cdot 9$.
7-septate............	$56 – 90 \times 4 – 6$.........	Mostly $67 – 77 \times 4 \cdot 2 – 5 \cdot 2$.
9-septate............	$80 – 94 \times 4 \cdot 5 – 6$.......	Average $84 \times 4 \cdot 5$.

Stroma pale or flecked with blue; small sclerotia occur more or less frequently, and are spherical, dark blue or pale.

Hab. *Citrus limonia* Osbeck, on lemons kept 7 weeks in storage; fruit from Sunday's River, Cape.

Citrus sinensis Osbeck, from stem end rot in navel oranges, after 18 weeks in storage (5 isolations); fruit from Sunday's River, Cape.

From bark of orange tree, cracking and gumming above union, on trees of which roots were water-logged, Letaba, N. Transvaal, 1931, M.H. 28417.

Coffea arabica L., on berries, from Lemana, N. Transvaal, Jan. 1930 (Watson).

This variety has been found on trees, often associated with scale insects, or with other fungi such as *Nectria coccophila* and *Meliola* spp., in tropical and sub-tropical regions of America, Asia and Australia, rarely in Europe.

Growth on Standard Media.

Oat agar: Aerial mycelium moderate to sparse, short, tomentose, white or tinged salmon buff. Growth in substratum colourless. Groups of sporodochia and pionnotes developed freely after 2 weeks; they were pale ochraceous salmon to flesh colour, fading after 8 weeks to light vinaceous cinnamon.

Hard potato agar: Slant covered with a moderate amount of mycelium, which was usually short, cottony to tomentose, white or tinged salmon colour. Growth in substratum colourless. Pionnotes and sporodochia formed after 14 days; they were salmon colour.

Standard synthetic agar plus starch: Aerial mycelium sparse, white, or none. Growth in substratum colourless, or with a tinge of deep brownish vinaceous at the top of the slant Pionnotes and sporodochia developed freely after 14 days; they were pale ochraceous salmon to flesh colour, fading with age to light vinaceous salmon. In one strain, a few small, blue-black sclerotia were present after 3 months.

Potato agar plus 5 per cent. dextrose: Aerial mycelium wanting, or short, white tomentose. Growth in substratum colourless, or white to grenadine pink, fading to salmon colour, and, after 30 days, to vandyke brown. In one strain, a few minute, deep delft blue sclerotia developed near the base of the slant.

Potato plug: Growth rather slow; mycelium fine, short, compact, white or tinged salmon buff. In one strain, after 4 weeks, there were patches of bluish green in the substratum. Spore masses formed between the medium and the glass; in cultures 8 weeks old, they were light vinaceous cinnamon.

Melilotus stem: Growth slow; mycelium sparse, tomentose, white or tinged ochre in places. Small sporodochia developed; they were at first pale ochraceous salmon, fading after 8 weeks to light pinkish cinnamon.

Bean pod: Aerial mycelium developed more rapidly than on melilotus stems; it was cottony to tomentose, and white or tinged salmon buff in places. Sporodochia and pionnotes developed after 14 days; they were pale ochraceous salmon to salmon colour.

Rice: Growth slow; mycelium at first white, seashell pink and naples yellow. In some cases the growth remained pale, in others it became flesh colour to carrot red, and ater wood brown. In some tubes fairly numerous, small, flesh colour sporodochia developed.

Measurements of Conidia.

Oat agar, culture 2 weeks old, conidia from sporodochia.

7-septate............	0·5 per cent......	90 × 6.
6-septate............	4·5 ,, ...	75–95 × 4·5–6, mostly 5 μ wide.
5-septate............	94 ,, ...	60–87·5 × 4·5–6, mostly 5 μ wide.
4-septate............	1 ,,	
3-septate............	Few...............	45–50 × 4–4·5.

Standard synthetic agar plus starch, culture 2 weeks old, conidia from pionnotes.

8-septate............	0·5 per cent......	67–85 × 5·5.
7-septate............	9 ,, ...	50–80 × 5–5·5.
6-septate............	8 ,, ...	67–82·5 × 5–5·5.
5-septate............	81 ,, ...	50–80 × 4–5·5.
4-septate............	1 ,, ...	40–45 × 4–4·5.
3-septate............	0·5 ,, ...	30–42·5 × 4 4·5.

Standard synthetic agar plus starch, culture 5 weeks old, conidia from pionnotes.

8-septate............	1·5 per cent......	97·5–105 × 5–5·5.
7-septate............	21 ,, ...	90–112·5 × 4–5·5.
6-septate............	30 ,, ...	87·5–107·5 × 4–5·5.
5-septate............	46 ,, ...	62·5–95 × 4–5.
3-septate............	1·5 ,, ...	35–65 × 4–4·5.

Bean pod, culture 2 weeks old, conidia from sporodochia.

8-septate............	0·5 per cent......	85–105 × 5.
7-septate............	2 ,, ...	75–85 × 5.
6-septate............	4 ,, ...	62·5–70 × 4·5–5·5.
5-septate............	88 ,, ...	60–70 × 4–5.
4-septate............	1 ,, ...	42·5–50 × 4·5–5.
3-septate............	4·5 ,, ...	32·5–52·5 × 3·75–4·5.
1-septate............	Few...............	10–15 × 4–5.
0-septate............	Few...............	10–12 × 3·75–5.

Fusarium stilboides Wr.

Wollenweber, Fusarium-Monographie, 385, 1931; Fus. aut. del. 966–968. Wollenweber and Reinking, Die Fusarien, 94–95, 1935.

Syn. *Fusarium stilboides* v. *minus* Wr.

F. fructigenum Fr. v. *majus f.* 1 Wr. et Rkg.

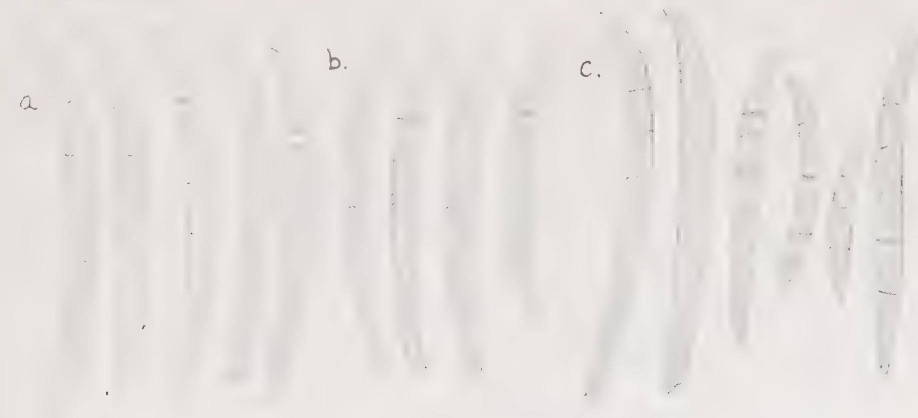

Fig. 21.

Fusarium stilboides Wr.; Conidia from (*a*) pionnotes of 2 weeks old culture on oat agar, (*b*) sporodochia of 4 weeks old culture on Melilotus stem and (*c*) pionnotes of 4 weeks old culture on hard potato agar.

Aerial mycelium floccose, abundant or sparse, at first white, then becoming pink or yellow through diffusion of colour from the stroma. Plectenchymatous stroma honey yellow to carmine red. The mycelium may also be flecked with blue in the neighbourhood of small dark blue, sclerotial masses, which later become covered with a conidial layer. Conidia at first scattered or in false heads, later produced in sporodochia and pionnotes. Conidia are often produced so freely, that sporodochia become columnar and up to several

millimetres long. Smaller 0–1-septate conidia occur, but are scarce and scattered; they are oval, fusiform of pyriform; 2–3-septate conidia are also scarce. Macroconidia in sporodochia and pionnotes are large, cylindrical, more curved at the ends than in the middle, constricted at the apex, definitely pedicellate at the base, mostly 5-septate, less frequently 3–7- exceptionally 8–16-septate.

0-septate............	5– 11 × 2·5–3......	Average 7 × 2·7.
1-septate............	11– 19 × 2·8–5·7....	Average 15 × 3·2.
3-septate............	16– 48 × 2·7–5......	Mostly 24–33 × 3·1–4.
5-septate............	40– 97 × 3·3–6......	Mostly 48–73 × 3·5–5·1.
7-septate............	56–105 × 3·5–6......	Mostly 66–90 × 4–5·1.
9-septate............	69–110 × 3·8–6......	Mostly 70–92 × 4·3–5·2.
10–16-septate............	70– 98 × 5–6.	

Dark blue, spherical sclerotia, 0·35–0·6 mm. in diameter, sometimes occur on the stroma. Chlamydospores wanting.

Hab. *Carica papaya* L., from rotting pawpaw fruit (fruit covered with rose coloured mycelium) Bathurst, Cape, Nov. 1931.

Citrus sinensis Osbeck, from more or less extensive, stem end rot of navel and Valencia oranges, after 6–18 weeks in storage; fruit from White River, E. Transvaal.

Coffea arabica L., on coffee berries, Lemana, N. Transvaal, Jan. 1931 (Watson) M.H. 28408. In this collection, *F. stilboides* was associated with *F. lateritium* v. *longum* and a *Capnodium* sp.; the presence of the latter fungus suggests that the berries had been attacked by scale insects.

This species has often been found associated with *Nectria coccophila* on scale insects, on living leaves and branches of *Citrus* spp., and on blister rust, (*Peridermium*) on *Pinus* chiefly in sub-tropical regions, but also in the temperate zone. It is known in America, Asia and Australia.

Growth on Standard Media.

Oat agar: Aerial mycelium fairly short and sparse, white, cobwebby. Growth in substratum eugenia red to acajou red and ochraceous buff to primuline yellow. In old cultures, there sometimes developed a few large, erect, branched sclerotial outgrowths, which were dirty white to greenish blue. Sporodochia began to develope after 7 days. they were numerous, minute (up to 1 mm. diam.), and frequently coalesced to form a pionnotal layer; they were light pinkish cinnamon or were stained with the colour of the stroma.

Hard potato agar: Aerial mycelium sparse, white, chiefly at the top of the slant; Growth in substratum colourless. Pionnotes formed after 7 days; they were light vinaceous cinnamon.

Standard synthetic agar plus starch: Aerial mycelium sparse to none. Growth in substratum eugenia red to acajou red and honey yellow to ochre; after 8 weeks this colour had faded. Sporodochia and pionnotes as on oat agar.

Potato agar plus 5 *per cent. dextrose:* Aerial mycelium none, or rose colour to honey yellow. Growth on substratum pale to indian lake, or carmine to ox-blood red. Pionnotes, when present, copious, pinkish buff to light pinkish cinnamon.

Potato plug: Growth slow, white, wrinkled, felt-like; or aerial mycelium rather coarse, rose pink to deep rose pink and yellow. Growth in substratum indian lake to pomegranate purple. Sporodochia rather large, forming erect columns to a height of 3–4 millimetres, light pinkish cinnamon.

Melilotus stem: Aerial mycelium scanty, or covering the stems; in the latter case it is sericeo-tomentose, and white to deep rose pink and rose colour. Numerous minute sporodochia developed in groups and formed slender columns 1–2 mm. long; they were light pinkish cinnamon.

Bean pod: Aerial mycelium sparse, white; or more vigorous, tomentose, and tinged rose pink and mustard yellow. Pionnotes and small sporodochia appeared after 7 days and were light vinaceous cinnamon.

Rice : Aerial mycelium white to naples yellow and mustard yellow ; growth on substratum honey yellow and amaranth purple. The red and yellow colour faded after 4 weeks, and the rice was then wood brown, Some pinkish cinnamon sporodochia developed on the grains.

Measurements of Conidia.

Oat agar, culture 4 weeks old, conidia from sporodochia.

7-septate............	2 per cent..........	60–65 × 4·7–5.
6-septate............	11 ,, ...	52·5–65 × 5.
5-septate............	59 ,, ...	40–77·5 × 3·75–5.
4-septate............	25 ,, ...	35–67·5 × 3·75–5.
3-septate............	3 ,, ...	25–55 × 3·75–4·7.
5-septate conidia sometimes over 90 per cent.,		50–70 × 4–5.

Hard potato agar, culture 4 weeks old, conidia from pionnotes.

7–8-septate............	Rare................	73–85 × 5–6.
6-septate............	1 per cent........	65–75 × 5.
5-septate............	57 ,, ...	46–68 × 4·7–5.
4-septate............	17 ,, ...	40–60 × 4·7–5.
3-septate............	24·5 ,, ...	29–59 × 3·7–4·7.
2-septate............	0·5 ,,	

Potato plug, culture 4 weeks old, conidia from sporodochia.

6-septate............	0·5 per cent........	52·5–65 × 5.
5-septate............	80·5 ,, ...	52·5–79 × 5.
4-septate............	11·5 ,, ...	52·5–63 × 4·7–5.
3-septate............	6·5 ,, ...	30–55 × 3·75–5.
1-septate............	1 ,,	

The size of the conidia in the strains studied was somewhat below the average for the species ; they were at first diagnosed as v. *minus* this variety now being merged in the species.

Section LISEOLA.

Fungi belonging to this section have two conidia forms, micro- and macroconidia. Microconidia minute, 0–1-septate, fusiform to ovoid, seldom pyriform, in some forms produced in long chains or false heads, later scattered freely and forming a light powder over the mycelium. Macroconidia delicate, slender, subulate, almost cylindrical, almost straight or curved, somewhat dorsiventral, fusiform to falcate, tapering at both ends, sometimes bent at rather a sharp angle, abruptly constricted at the apex, more or less pedicellate at the base. The conidia vary in form between those of the *Lateritium* and *Roseum* sections, and also somewhat resemble those of the *Elegans* section. Macroconidia scattered, or in sporodochia and pionnotes ; in mass they are brownish white, or isabellinous to salmon orange, when dry becoming brick red, cinnamon brown or pale. Chlamydospores wanting. Stroma effuse, plectenchymatous, pale, brownish white, pink or violet, smooth, wrinkled or sclerotially erumpent, and sometimes bearing spherical, dark blue sclerotia. Some representatives of this group are the conidial forms of *Gibberella*.

Only two forms have been found in South Africa :—

Microconidia in chains......................	*F. moniliforme.*
Microconidia not in chains....................	*F. moniliforme* v. *subglutinans.*

Fusarium moniliforme Sheldon.

Sheldon, A corn mould (*Fusarium moniliforme* n. sp.), Nebraska Agric. Exp. Sta. Rept. 17 : 23–32. 1904. Wollenweber, Fusarium-Monographie, 391–395, 1931 ; Fus. aut. del. 197, 366, 970–973, 976. 1157–1161. Wollenweber and Reinking, Die Fusarien, 98–100, 1935.

Syn. *Fusarium moniliforme* Sheld. v. *erumpens* Wr. et Rkg.
F. moniliforme Sheld. v. *majus* Wr. et Rkg.
F. moniliforme Sheld. v. *fici* Caldus.
F. celosiae Abe ; *F. samoense* Gehrm. pr. p.

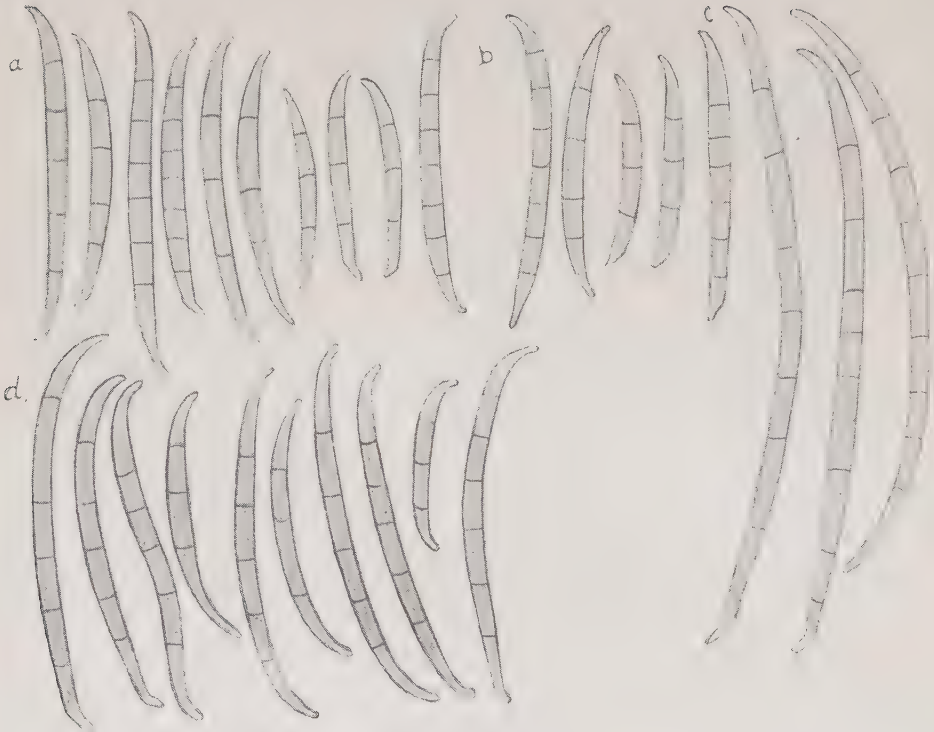

Fig. 22a.

Fusarium moniliforme Sheld.; conidia from (*a*) sporodochia of 12 weeks old culture on standard synthetic agar plus starch, (*b*) sporodochia of 11 weeks old culture on oat agar, (*c*) longer forms often predominant in pionnotes of 2 weeks old cultures on standard synthetic agar plus starch, (*d*) conidia from sporodochia of 12 weeks old culture on standard synthetic agar plus syarch , (*a-c*) strain from tomato seed, (*d*) from maize.

Microconidia in chains or in false heads, 1–2-celled, fusiform-ovoid, usually very numerous, and later, when scattered, forming an inconspicuous light powder over the aerial mycelium ; the powder is isabellinous or pinkish. Macroconidia delicate, subulate, slightly curved or almost straight, tapering at both ends, often constricted and sometimes rather abruptly bent at the apex, pedicellate or sub-pedicellate at the base. Macroconidia scattered, or produced in sporodochia and pionnotes, in mass pale, isabellinous or salmon orange, becoming brick red to cinnamon red or pale when dry.

0-septate............	4–18 × 1·5–4.........	Mostly 5–12 × 2–3.
1-septate............	9–30 × 2–5..........	Mostly 12–22 × 2·2–3·5.
3-septate............	20–60 × 2–4·5.......	Mostly 32–50 × 2·7–3·5.
5-septate............	37–70 × 2–4·5.......	Mostly 41–63 × 2·7–4.
7-septate............	58–90 × 2·5–4·5.....	Mostly 61–82 × 2·7–4·2.

Chlamydospores wanting. Dark blue sclerotia, 0·08 × 0·1 mm. diam., may be present or absent. Stroma more or less plectenchymatous, yellowish, brownish or violet.

This species is very variable in the size and septation of its conidia. It occurs in tropical and sub-tropical regions of Asia, America, Africa, Australia and Melanesia, on a number of different hosts ; it is chiefly known as a parasite of cereals and other grasses.

The ascus stage of *F. moniliforme* is *Gibberella Fujikuroi* (Saw.) Wr., which was first described on rice in 1917. It has not been found in South Africa, but is known elsewhere on rice, sugar cane and maize, and possibly on other host plants.

Gibberella Fujikuroi (Saw.) Wr.

Syn. *Lisea Fujikuroi* Saw.

Wollenweber and Reinking, Die Fusarien, 99–100, 1935. Wollenweber, Fus. aut. del. 819, 820.

Gibberella moniliformis (Sheld.) Wineland.

Fig. 22b.

Fusarium moniliforme Sheld.; from plain agar plates, conidiophores bearing microconidia.

Perithecia dark blue, spherical to ovoid, verrucose, 0·19–0·39 × 0·16–0·42 in diameter. Asci paraphysate. Paraphyses septate, clavate, 84–150 × 9–18 μ. Asci cylindrical to clavate, flattened at the apex, 66–129 × 7–14, mostly 4–6-spored, seldom 8-spored. Spores monostichous or imperfectly distichous, 1-septate, 10–24 × 4–9, mostly 14–18 × 4·4–7. Spores occasionally 2–4-septate before germination.

This fungus is the cause of the so-called "*Bakanae*"-disease of rice seedlings, the "*Pokkah-boeng*" disease of sugar cane, and of similar diseases of maize.

The conidial stage has been found on a number of hosts in South Africa.

Hab. *Allium Cepa* L., from rotting bulb of onion, Pretoria, 1929 (ass. *F. vasinfectum* v. *zonatum f.* 2) (Wager).

Ananas comosus Merr., from brown, decaying spots in pineapples from Bathurst Dist., Cape, offered for sale in Pretoria (brown spots round flowers more extensive and lighter in colour than those caused by *Penicillium* sp.).

Brassica oleracea L., from stems of wilting plants, Buffelspoort, Marikana, Rustenburg Dist. (ass. *Rhizoctonia* and *Pythium* sp.) (Turner).

Citrus sinensis Osbeck, from fruit showing stem end rot after 12–18 weeks in storage; navel oranges from Sunday's River, Cape, and Rustenburg, Transvaal, and Valencia oranges from Sunday's River.

Eleusine indica Gaertn., from stems of goose grass (ass. *Helminthosporium* sp.) Acton Homes, Natal, 1931 (L. A. Doidge).

Euphorbia crassipes Marloth, on rotting stems, Willeston, Cape (ass. *F. lateritium*).

Gossypium sp., from stems of wilting seedlings, probably following *Pythium* sp., Rustenburg, Transvaal (Moore).

Lycopersicum esculentum Mill., on seed offered for sale, Pretoria, (several isolations (Wager).

Musa Sapientum L., from fruit affected by 'tip rot,' Acornhoek, (Boyce).

Nicotiana Tabacum L., from stems of wilting seedlings, probably following *Pythium*. sp., Rustenburg (Moore).

Persia americana Mill., from roots of trees shewing die-back (also from soil), Malelane, E. Transvaal (Wager).

Phlox Drummondii Hk., from stems of wilting plant (ass. *Rhizoctonia*), Pretoria.

Pisum sativum L., from wilting stem, Carnarvon, Cape (Wager).

Pyrus malus L., from brown cores of fruit, Vereeniging, 1935–1936 (Bottomley).

Solanum tuberosum L., from tubers affected by dry rot, Umhlanga Beach, nr. Mt. Edgecombe, Natal (van der Plank).

Sorghum vulgare Pers. v. *Caffrorum* Beauv. (= *Andropogon sorghum*), from heads of kaffir corn moulding in the sheath, Pretoria University farm (F. du Toit).

Sorghum vulgare Pers. v. *technicum* (Koern.) Jab., from rotting stem of broom corn, Pretoria University farm (F. du Toit).

Striga lutea Lour., from stems of dying witchweed plant, Pretoria (F. du Toit).

Triticum sp., from stems of wheat plants with blind ears, Losperfontein, Transvaal (Leeman).

Zea Mays L., from mouldy grain, cobs and maize meal; Bethal, O.F.S. (meal said to be unfit for human consumption) M.H. 28382; Settlers, Springbok Flats (grain showed a low percentage of germination) (E. du Toit); Louis Trichardt, N. Transvaal (maize germinating on cobs); Pretoria (young green mealie cob on Pretoria market, grains turning light brown and decaying in patches with some pink discoloration).

From stems of plants which were stunted or were affected by foot rot (numerous isolations), Pretoria, Immerpan and Warmbaths, Transvaal.

Eggs, from purplish brown, discoloured patches on membrane, which at this point adhered to the shell, albumen partly coagulated (ass. *F. semitectum* v. *majus*) sent by Poultry Inspector, Port Elizabeth (Bottomley).

Growth on Standard Media.

Oat agar: Aerial mycelium usually fairly plentiful, matted, arachnoid, white to hydrangea pink and pale brownish vinaceous. Growth on substratum colourless, or deep purplish vinaceous to perilla purple; in older cultures it was sometimes blue-black in places. Pionnotes, when present, pale pinkish cinnamon.

Hard potato agar : Mycelium scant to moderate in amount, white to seashell pink' rather coarse, cottony, or mealy in appearance owing to the presence of numerous conidia' Pionnotes, when present, light ochraceous salmon to vinaceous.

Standard synthetic agar plus starch : Aerial mycelium none or scanty, white or tinged pinkish buff. Growth in substratum vinaceous lavender to deep purplish vinaceous ; the medium sometimes had a brownish tinge. Pionnotes formed over the face of the slant ; they were pinkish buff to pinkish cinnamon.

Potato agar plus 5 per cent. dextrose : Aerial mycelium sparse to moderate in amount, cottony or tomentose, white to flesh pink or light vinaceous lilac. Growth in substratum vinaceous purple to delft blue and blue-black. Sometimes the agar under the slant was stained acajou red.

Potato plug : Plug covered with a dense, matted mycelium, which was white to pale flesh colour or pale vinaceous lilac. A few minute, deep delft blue sclerotia developed in some tubes, and a few small sporodochia.

Melilotus stem : Growth scant to moderate in amount, white to seashell pink, cottony or mealy owing to the presence of numerous conidia.

Bean pods : Pods covered with a mycelium which was dense, downy or cobwebby, or rather sparse, coarse and tomentose ; it was white to ochraceous salmon or pinkish cinnamon. Pionnotes developed in some tubes.

Rice : Growth at first white to alizarine pink and old rose ; after 6 weeks, it was alizarine pink to eugenia red and dark vinaceous in places, spinel red next to the grains ; at the base of the tube, there was a tinge of dusky auricula purple. The grains were light ochraceous buff to mustard yellow.

Measurements of Conidia.

Standard synthetic agar plus starch, culture 3 months old, conidia from mycelium.

6-septate	1 per cent	55–62·5 × 3–3·75.
5-septate	6 ,,	40–60 × 3–3·75.
4-septate	1 ,,	40–45 × 3–3·75.
3-septate	32 ,,	22·5–57·5 × 3–3·75.
2-septate	1 ,,	20–25 × 2·5–3.
1-septate	7 ,,	12·5–20 × 2–3.
0-septate	52 ,,	5–10 × 2·5–3·75.

Standard synthetic agar plus starch, culture 14 days old, conidia from pionnotes.

11–13-septate	117·5–147·5 × 4·5.
10–12-septate	100–120 × 3·75–4·4.
8–9-septate	85–117·5 × 2·8–4·4.
7-septate	75–112·5 × 3·7–4·5.
6-septate	62·5–85 × 2·8–5.
5-septate	40–82·5 × 2·8–3·75.
4-septate	56 × 2·5.
3-septate	25–52·5 × 3–3·75.

Hard potato agar, culture 14 days old, conidia from pionnotes.

7-septate	Few	65–82·5 × 3·75.
6-septate	0·5 per cent	65–77·5 × 3–3·75.
5-septate	3 ,,	47·5–72·5 × 3–4·5.
4-septate	3·5 ,,	45–64 × 3·75.
3-septate	14 ,,	32·5–70 × 2·8–3·75.
0–1-septate	79 ,,	

The above measurements were from different cultures of the same strain, and serve to illustrate the variability in the size and septation of the conidia of *F. moniliforme.*

Fusarium moniliforme Shel. var. subglutinans Wr. et Rkg.

Wollenweber and Reinking, Phytopathology 15: 163, 1915; Die Fusarien, 100–101, 1935; Wollenweber, Fusarium-Monographie, 397, 1935; Fus. aut. del. 974, 1121, 1122.

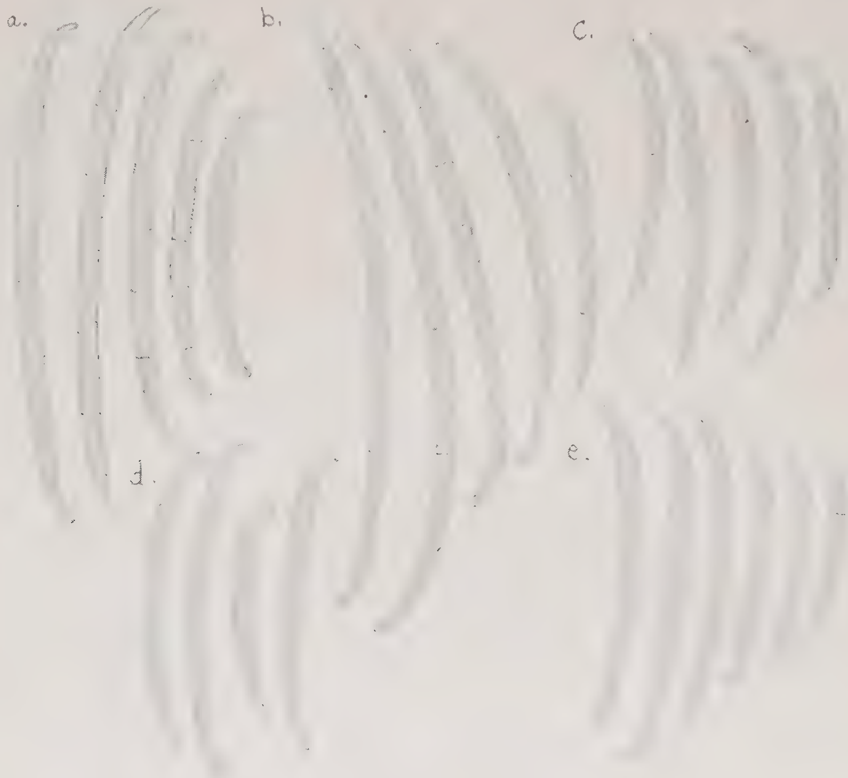

FIG. 23A.

Fusarium moniliforme Sheld. v. *subglutinans* Wr. et. Rkg.; conidia from (*a*) pionnotes of culture on hard potato agar, (*b*) pionnotes of culture on oat agar, (*c*) pionnotes of culture on potato plug, (*d*) pionnotes of culture on oat agar, (*e*) sporodochia of rice culture; cultures all 4 weeks old; (*a-c*) strain 632 and (*d-e*) strain 631, both from maize.

This form differs from the type chiefly in the microconidia, which are not produced in chains. The macroconidia are 3–5-septate, seldom 7-septate.

0-septate............	6–15 × 1·7–4........	Mostly 7–12 × 2–3·5.
1-septate............	10–28 × 2·2–4·5.....	Mostly 14–20 × 2·5–3·5.
3-septate............	18–60 × 2·5–4·5.....	Mostly 25–48 × 3–4.
5-septate............	40–61 × 3–4·5.......	Mostly 43–53 × 3·2–4.
6–7-septate............	48–57 × 3·25–4·5.	

Chlamydospores wanting. Dark blue, spherical sclerotia and irregular, erumpent sclerotial stromata may be present or absent.

This variety occurs on wheat, maize, sugar-cane and other Gramineae, and on a number of other hosts in tropical and sub-tropical regions of America, Asia, Africa and Australia; it occurs less frequently in Europe. The ascus stage has been found in Australia by Edwards (15) and may be described as follows :—

Gibberella Fujikuroi (Saw.) Wr. var. **subglutinans** Edwards.

Edwards, Dept. of Agric. New South Wales, Sci. Bull. 49, 1935. Wollenweber and Reinking, Die Fusarien, 101, 1935. Wollenweber, Fus. aut. del. 1121, 1122.

The perithecia are dark blue, somewhat rough, spherical to ovoid, and are similar in size to those of the type. Asci paraphysate, 4 8-spored, clavate. Paraphyses ascending from the base of the perithecium, about 6-celled, 70–100 × 6–15. Spores 1-septate, 11–22 × 3–8; exceptionally 2–3-septate, 18–23 × 4–6.

On maize, causing a disease of seedlings and older plants. Only the conidial stage has been found in South Africa.

Hab. *Brassica oleracea* L., from stems of dying cabbage plants (ass. *Rhizoctonia* and *Pythium* sp.), Buffelspoort, Marikana, E. Transvaal (Turner).

Citrus sinensis Osbeck, from stem end rot of Valencia oranges after 18 weeks in storage, fruit from Rustenburg, 1933–34.

Kniphofia sp., on capsules, Loskop, Natal (Galpin) M.H. 28385.

Pyrus malus L., from brown cores of fruit, Vereeniging, 1935–36 (Bottomley).

Saccharum officinarum L., from dying leaf of sugar cane, Durban, Oct. 1931 (McLean).

Zea Mays L., from mouldy grain, cob and maize meal, Bethal, O.F.S., M.H. 28379 and 28380; Zoological Gardens, Pretoria; Klip River, Natal (Watts) M.H. 28413; Kenya (McDonald) M.H. 28422; from maize germinating on cob, Driehoek, Piet Retief (Leemann).

From stems (upper nodes) and collapsed leaf bases, Kinross, Transvaal, M.H. 28406.

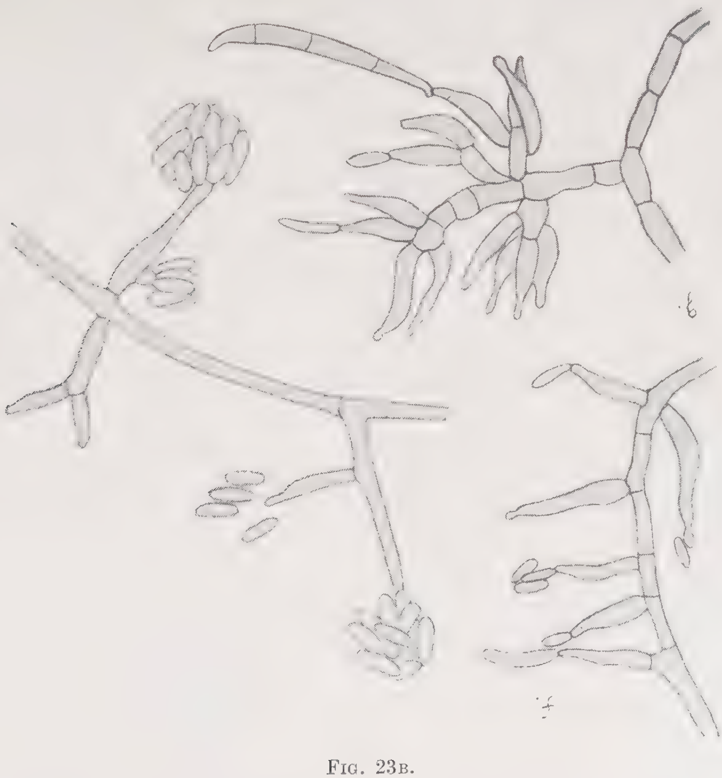

Fig. 23b.

Fusarium moniliforme Sheld. v. *subglutinans* Wr. et. Rkg.; conidiophores bearing micro- and macroconidia.

Growth on Standard Media.

Oat agar: Aerial mycelium very sparse, or more frequently wanting. Growth in substratum pale to deep purplish vinaceous, anthracene purple and perilla purple. When the stroma was purple, the agar became stained the same colour. Pionnotes rather thin, flesh colour to salmon buff.

Hard potato agar: Aerial mycelium short, sparse, tomentose; growth in substratum colourless, or with patches of blue-black near the base of the slant. A few salmon buff sporodochia developed.

Standard synthetic agar plus starch: Aerial mycelium sparse to none; growth on substratum pale or acajou red to deep purplish vinaceous; when purplish, the colour of the stroma became diffused into the agar. Pionnotes light vinaceous cinnamon, or becoming reddish through absorption of the colour of the stroma.

Potato agar plus 5 per cent. dextrose: Aerial mycelium short, sparse, rather coarse, tomentose, white to pale vinaceous lilac. Growth on substratum perilla purple to vandyke red and Hay's maroon. Pionnotes at first salmon buff; both pionnotes and agar became stained with the colour of the stroma.

Potato plug: Plug covered with copious mycelium, which was cottony, white to flesh pink. Growth in substratum was deep delft blue in patches, and a few minute, blue-black sclerotia were sometimes present. Pionnotes developed freely, they were light ochraceous salmon to salmon.

Melilotus stem: Stems covered with a short, tomentose mycelium, which was white to congo pink. Conidia were produced in a dense, vinaceous cinnamon pionnotes, or light ochraceous salmon sporodochia developed; these coalesced when numerous, and formed a continuous pionnotal layer.

Bean pod: Aerial mycelium short, sparse, white; patches of blue-black sometimes developed on the substratum. Pionnotes very copious, salmon colour to cinnamon.

Rice: Growth Chatenay pink and pale vinaceous lilac to perilla purple. Pionnotes or sporodochia often developed on the surface of the grains; they were salmon colour to cinnamon.

Measurements of Conidia.

Hard potato agar, culture 2 weeks old, conidia from pionnotes.		
5-septate	8 per cent	52·5–85 × 2·8–3·75.
4-septate	8 ,,	47·5–70 × 2·8–3·5.
3-septate	38 ,,	22·5–55 × 2·8–3·5.
2-septate	3 ,,	18–28 × 2·4–4·5.
1-septate	23 ,,	9–18 × 2·4–3·6.
0-septate	20 ,,	4–11 × 2·5–4.
Bean pod, culture 2 weeks old, conidia from pionnotes.		
6-septate	Few	55–57·5 × 3–3·75.
5-septate	2 per cent	42·5–57·5 × 2·8–3.
4-septate	5 ,,	42·5–52·5 × 2·8–3.
3-septate	64 ,,	20–50 × 2·5–3.
2-septate	3 ,,	22–27 × 3–3·5.
1-septate	18 ,,	10–19 × 3–3·5.
0-septate	8 ,,	5–12 × 2·5–3·5.
Potato plug, culture 5 weeks old, conidia from sporodochia.		
6-septate	1 per cent	43·5–45 × 3·65–4·5.
5-septate	25 ,,	35–47·5 × 3·75–4·5.
4-septate	18 ,,	35–47·5 × 3–4·5
3-septate	35 ,,	22·5–40 × 2·8–5.
2-septate	1·5 ,,	20 × 2·8.
1-septate	8 ,,	18–24 × 2·8.
0-septate	11·5 ,,	4·5–2 × 2·5–3·5.

Oat agar, culture 5 weeks old, conidia from pionnotes.

6-septate............	Rare.................	42·5 × 4·4.
5-septate............	3 per cent..........	37·5–50 × 4–4·5.
4-septate............	4 ,, ...	37·5–52 × 3·5–4·5.
3-septate............	44 ,, ...	19–42·5 × 2·8–4·5.
2-septate............	1 ,, ...	18–25 × 3–3·75.
1-septate............	9 ,, ...	11–20 × 2·8–3.
0-septate............	39 ,, ...	6–12 × 2·5–3.

Section ELEGANS.

Wollenweber, Phytopathology 3: 28, 1913; Fusarium-Monographie, 400–406, 1931. Wollenweber and Reinking, Die Fusarien, 104–109, 1935.

Fungi with two conidial forms, microconidia and macroconidia. Microconidia ovoid-ellipsoid, straight or reniform, 5–12 × 2·2–3·5, single on free conidiophores, or loosely agglutinated in false heads. Macroconidia in tubercularia-like sporodochia or in an extended pionnotal layer, on closely crowded, freely branched conidiophores. The conidial masses are formed on an erumpent or flat, plectenchymatous or sclerotial stroma; they form a convex layer, or appear in small masses, like grains of sand, which readily become coalescent; when dry, these form a hard, resinous crust, or a powdery layer. In some species, the macroconidia are elongated, fusiform to subulate, tapering at both ends or slightly constricted; in others they are more compact, fusiform-falcate, usually constricted and abruptly curved at the apex, and pedicellate or papillate at the base. Macroconidia are dorsiventral to almost cylindrical, thin-walled, usually with 3, or up to 5, delicate cross walls; their measurements vary, but they are of medium size, 3-septate 27–46 × 3–5, 5-septate 50–60 × 3–5; in mass they are pale, isabellinous, brownish-white, flesh colour to salmon orange. Mycelium white, or stained with the colour of the stroma. Stroma pale or pink, orange colour or purple red, plectenchymatous, effuse or raised, more or less erumpent and sclerotial, with smooth or wrinkled surface, and sometimes with elongated or stalk-like outgrowths which are light, or dark green to blue-black. Chlamydospores plentiful, terminal and intercalary, in mycelium and conidia. Sclerotia, which may be rough, and brown, blue or pale, present or wanting.

This group includes a number of organisms causing vascular wilt diseases, which are more or less specific, on certain hosts, and also organisms causing rots of bulbs, tubers, roots and fruit.

A number of species and varieties have been recorded on various hosts in South Africa; it is possible that other cosmopolitan wilt-organisms are present, and have not yet been identified. In addition to the forms recorded on the following pages, undetermined strains of Fusaria belonging to the *Elegans* section have been isolated from the following hosts: *Crotalaria juncea*, *Dahlia* sp., *Datura stramonium*, *Dimorphotheca aurantiaca*, *Fragaria* sp., *Gilia rubra*, *Persea americana*, *Physalis angulata*, *Prunus persica* and *Rheum rhaponticum*. A full key is given to the species of this section, which comprises so large a number of specific plant parasites.

Key to the Species.

A.—Fungi typically without sporodochia............... **Sub-section Orthocera.**

a.—Pionnotes typically wanting. Conidia 1-celled, or sparingly septate.

b.—Conidiophores with bostrycoid branching..... *F. bostrycoides.*

bb.—Conidiophores simple, or with branches in whorls.

c.—Stroma pale, brownish white to flesh colour.

d.—Plectenchyma sometimes erumpent. Macroconidia not numerous.
e.—Conidia when 3-sept., 34 × 3·5; 5-sept., 43 × 3·6; 7-sept., 59 × 3·7.......................... *F. conglutinans* v. *callistephi*
dd.—Plectenchyma not erumpent. Macroconidia not numerous, 3-sept. 30 × 3·4.
e.—Pathogenic to *Brassica oleracea* *F. conglutinans.*
ee.—Pathogenic to *Beta vulgaris*..... *F. conglutinans* v. *betae.*
eee.—Pathogenic to *Apium graveolens* *F. orthoceras* v. *apii f.* 1.
eeee.—Pathogenic to *Pisum sativum*... *F. orthoceras* v. *pisi.*
cc.—Stroma red, violet, red-brown or rust-red.
d.—Stroma chestnut brown, rust-red, pink; pea-wilt organism........... *F. orthoceras* v. *pisi.*
dd.—Stroma purple violet; conidia when 3-sept. 33 × 3·5; 5-sept. 43 × 3·9 *F. orthoceras.*
ddd.—Stroma red-violet; pathogenic to celery (*Apium graveolens*)........... *F. orthoceras* v. *apii.*
aa.—Pionnotes sparse or wanting.
b.—Stroma pale, brownish white, then yellow, not red.
c.—Conidia, when 3-sept., 28 × 3·5......... *F. conglutinans* v. *citrinum.*
bb.—Stroma pink to purple.
c.—Conidia, when 3-sept., 39 × 4; 5-sept., 49 × 4·4............................ *F. orthoceras* v. *longius.*
cc.—Conidia comparatively long, tapering gradually to the apex; 3-sept. 36 × 3·5; 5-sept. 60 × 4·2...................... *F. angustum.*
aaa.—Fungi sometimes with sporodochia.
b.—Macroconidia 3-sept. 30 × 3·2; or in sporodochia 3-sept. 35 × 4; pathogenic to flax (*Linum*) causing wilt...................... *F. lini.*
aaaa.—Fungi typically with sporodochia.
b.—Macroconidia comparatively slender, 3–3·7 μ thick.................................... **Sub-section Constrictum.**
c.—Conidia more or less 3-sept.
d.—Conidia very slender; 3-sept. 33 × 3·2............................. *F. bulbigenum* v. *tracheiphilum.*
dd.—Conidia somewhat thicker; 3-sept. 35 × 3·5........................ *F. bulbigenum* v. *blasticola.*
cc.—Conidia more or less 3–5-sept.
d.—Stroma more or less sclerotial, pale not blue.
e.—Conidia 3-sept. 37 × 3·4; 5-sept. 49 × 3·5..................... *F. bulbigenum* v. *lycopersici.*
dd.—Stroma, when sclerotially erumpent, blue to pale.
e.—Sclerotial bodies small, numerous, 0·1–3 mm.
f.—Conidia 3-sept. 36 × 3·3; 5-sept. 48 × 3·3........... *F. bulbigenum* v. *batatas.*
ee.—Sclerotial bodies comparatively large, scattered, 3–6 mm. diam.

f.—Conidia 3-sept. 38 × 3·4; 5-sept. 50 × 3·5........... *F. bulbigenum.*

ff.—Conidia 3-sept. 34 × 3·6; 5-sept. 47 × 3·6........... *F. bulbigenum* v. *niveum.*

bb.—Macroconidia comparatively stouter, 3·7–5 μ thick.. **Sub-section Oxysporum.**

c.—Sclerotia wanting; sclerotial plectenchyma not erumpent.

d.—Conidia not broader in the upper third than in the middle, nor abruptly bent at the apex. Stroma red-violet. Not aromatic. Conidia 3-sept. 38 × 4·3; 5-sept. 47 × 4·3............. *F. oxysporum* v. *aurantiacum f.* 1

dd.—Conidia often broader in the upper third than in the middle, usually abruptly bent near the apex; stroma lilac.

e.—Conidia in mass pale, cream to flesh colour, 3-sept. 36 × 4·7; 5-sept. 44 × 4·7.

f.—Aromatic odour developing in rice cultures............. *F. redolens.*

ff.—No aromatic odour......... *F. redolens f.* 1.

cc.—Sclerotia wanting, but plectenchyma more or less sclerotially erumpent.

d.—Stroma effuse, purple.

e.—Conidia 3-sept. 37 × 3·9; 5-sept. 42 × 4·1. Strongly aromatic.. *F. vasinfectum* v. *zonatum.*

ee.—Conidia 3-sept. 38·5 × 3·7; 5-sept. 42·1 × 4·1. Not aromatic.......................... *F. vasinfectum* v. *zonatum f.* 2.

dd.—Stroma effuse, salmon-orange, not or faintly aromatic.

e.—Conidia 3-sept. 37·1 × 3·8; 5-sept. 43 × 4................. *F. vasinfectum* v. *zonatum f.* 1.

ccc.—Sclerotia present. Sclerotial plectenchyma and sclerotia dark blue to green, sometimes paler.

d.—Sclerotial bodies comparatively small, 0·1–2 mm. or smaller.

e.—Conidia 3-sept. 33 × 3·7; 5-sept. 40 × 3·8.

f.—Pathogens causing cotton wilt.

g.—Fungus aromatic....... *F. vasinfectum.*

gg.—Fungus not aromatic... *F. vasinfectum f.* 1.

ff.—Not causing cotton wilt.... *F. vasinfectum f.* 2.

ee.—Conidia 3-sept. 34 × 3·8; 5-sept. 42 × 4; aromatic............. *F. vasinfectum* v. *lutulatum.*

dd.—Sclerotial bodies comparatively large, 0·5–3–6–12 mm.

e.—Stroma effuse, usually white to flesh colour.

f.—Conidia 3-sept. 35 × 4; 5-sept. 42 × 4·2. Not aromatic, pathogenic to aster (*Callistephus*) . . . . *F. oxysporum f.* 6.

ee.—Stroma effuse, pink, violet to red.

f.—Conidia 3-sept. 34 × 4; 5-sept. 42 × 4·2. Faintly aromatic. Pathogenic to onion (*Allium*), but not to potato . . . . *F. oxysporum f.* 7.

ff.—Conidia 3-sept. 35·1 × 4; 5-sept. 42·4 × 4·2. Aromatic or not aromatic. Pathogenic to peas (*Pisum*) . . . . . . *F. oxysporum f.* 8.

fff.—Conidia 3-sept. 35 × 4; 5-sept. 41 × 4·2. Usually aromatic.

g.—Cause of potato (*Solanum*) wilt . . . . *F. oxysporum f.* 1.

gg.—Cause of rotting in roots, tubers, fruit, etc.; not a specific potato organism. Aromatic or not aromatic . . . . *F. oxysporum.*

ggg.—Fungus with copious pionnotes. Cause of wilt of sweet potato (*Ipomoea*). Aromatic . . *F. oxysporum f.* 2.

eee.—Stroma effuse, red-violet. Conidia 3-sept. 35 × 4; 5-sept. 45 × 4·2.

f.—Sclerotia comparatively numerous. Not aromatic. Cause of wilt of tobacco (*Nicotiana*) *F. oxysporum* v. *nicotianae.*

ff.—Sclerotia comparatively few, seldom in groups. Cause of wilt of banana (*Musa*). Aromatic . . . . *F. oxysporum* v. *cubense.*

eeee.—Stroma effuse, dark purple to red-violet.

f.—Conidia 3-sept. 35 × 4·3; 5-sept. 45 × 4·3. Not aromatic . . . . *F. oxysporum* v. *aurantiacum.*

ff.—Conidia 3-sept. 33 × 4·3; 5-sept. 44 × 4·5; 7-sept. 42 × 4·8. Not aromatic. Cause of *Gladiolus* wilt . . . . *F. oxysporum* v. *gladioli.*

fff.—Conidia 3-sept. 40 × 4·4; 5-sept. 47 × 4·9. Not aromatic. Cause of wilt of lucerne (*Medicago*) . . . . *F. oxysporum* v. *medicaginis.*

ffff.—Conidia 3-sept. 34 × 4; 5-sept. 44 × 4·3. Not aromatic. Cause of wilt of carnation (*Dianthus*) . . . . *F. dianthi.*

Sub-section ORTHOCERA.

Without sporodochia ; pionnotal layers of limited extent sometimes occur. Macroconidia almost straight, fusiform, slightly constricted at both ends, papillate or sub-pedicellate at the base, 3–5-septate, slender, delicate. Three-septate conidia usually 8–10, (up to 12) times as long as broad, and 5-septate 11–13, (up to 17) times as long as broad ; 3-septate conidia 27–46 × 3–4 ; 5-septate conidia, which may or may not be present, 33–50 (up to 60) × 3·5–4. Chlamydospores spherical to pyriform, smooth or verrucose ; sclerotia and sclerotial stromata pale, or green to blue-black.

Fusarium Orthoceras. App. et Wr.

Appel and Wollenweber, Arb. biol. Reichanst. Land. u. Forstw. 8 : 141–156, 1910. Wollenweber, Fusarium-Monographie, 408, 1931 ; Fus. aut. del. 359–362, 620, 621, 985–989. Wollenweber and Reinking, Die Fusarien, 111–112, 1935.

Syn. *Fusarium albido-violaceum* Dasz.

F. orthoceras App. et Wr. v. *albido-violaceum* (Dasz.) Wr.

F. orthoceras App. et Wr. v. *triseptatum* Wr.

F. oxysporum Schl. v. *cucurbitacearum* Rabh.

F. oxysporum Schl. v. *resupinatum* Sherb.

F. oxysporum Schl. v. *asclerotium* Sherb.

F. asclerotium (Sherb.) Wr.

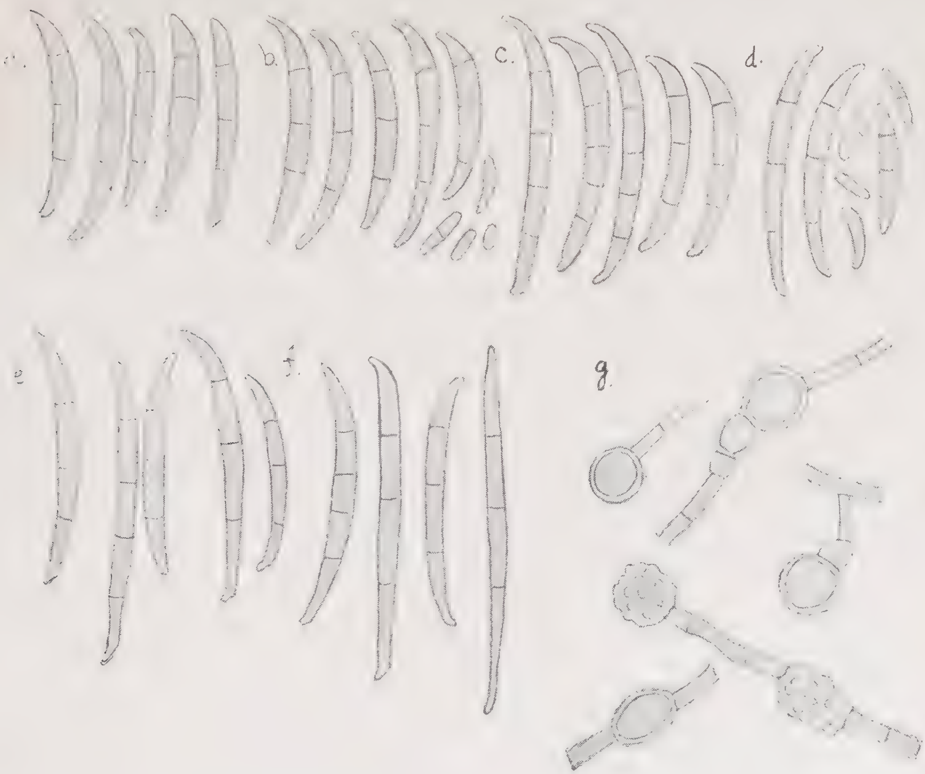

Fig. 24.

Fusarium orthoceras App. et Wr. ; conidia from mycelium of (*a*) 8 weeks old culture on Melilotus stem, (*b*) 4 weeks old culture on Melilotus stem, and 4 weeks olf cultures on (*c*) oat agar, (*d*) bean pods, (*e*) hard potato agar, and (*f*) standard synthetic agar plus starch, (*g*) chlamydospores from a 6 weeks old culture on oat agar.

Stroma caespitose, plectenchymatous, seldom sclerotially erumpent, flesh colour, flecked with green, or purple red to violet. Aerial mycelium usually abundant, floccose, white to pink, readily collapsing and then becoming tough, gelatinous. Conidia, forming freely on the mycelium, are 1-celled or sparsely septate; very few macroconidia are produced. Conidia abstricted successively from the tips of free conidiophores; they soon fall off, or become agglutinated into false heads; occasionally the conidiophores branch more freely, and form a thin, fugaceous, flesh-coloured pionnotes, or a few sporodochia. Microconidia ovoid-cylindrical, straight or curved. Macroconidia almost straight, fusiform-falcate, slender, delicate, indistinctly septate; papillate at the base, or with a tendency towards the pedicellate form.

0-septate............	4–17 × 2–4..........	Mostly 6–12 × 2·5–3·2.
1-septate............	10–41 × 2·5–4·5.....	Mostly 13–27 × 2·5–3·8.
3-septate............	15–61 × 2·4–4·8.....	Mostly 23–36 × 3–4·3.
5-septate............	25–69 × 3–4·8.......	Mostly 33–48 × 3·2–4·5.

Chlamydospores terminal and intercalary, spherical to pyriform, smooth or verrucose; 1-celled 6–14 × 5–13; less frequently 2-celled, 10–21 × 6–13.
Hab. *Solanum tuberosum* L., from tubers showing various forms of storage rot; from tubers imported from England and Germany; tubers from Mokeetsi, Pretoria (Wager) and Leslie, Transvaal; Cedara, (Gill) and Mt. Edgecombe (van der Plank) Natal. Also reported by du Plessis (13), in rotting tubers from Stellenbosch, Paarl and George in the winter rainfall area.

From base of stem of diseased potato plant, Molteno, Cape, March 1930 (Wager).

This fungus appears to be the most common cause of " dry rot " of potato tubers in South Africa. It is a cosmopolitan organism, and occurs more or less commonly in all parts of the world, on decaying subterranean parts of plants and in humus; it occurs less frequently on dead animals, e.g. chameleon.

Growth on Standard Media.

Oat agar : Aerial mycelium short, dense, matted, or sparse, white; Growth on substratum pale to vinaceous lilac, or vinaceous purple to slate violet. In cultures of one strain, a thin, light pinkish cinnamon pionnotes developed on the lower half of the slant.

Hard potato agar : Aerial mycelium moderate to sparse, short, white, cottony to tomentose. Growth on substratum colourless. A thin pionnotes occasionally developed.

Standard synthetic agar plus starch : Aerial mycelium sparse, white, mostly at the top and the bottom of the slant. Growth on substratum tinged light vinaceous purple to slate purple. In culture of one strain, a light pinkish cinnamon pionnotes developed, and also one or two minute sporodochia.

Potato agar plus 5 per cent. dextrose : Aerial mycelium sparse to none, or moderate, and then short, tomentose, white to tourmaline pink and hyssop violet. Growth on substratum flat, or raised and cushion-like, cream, pale purple drab, or light vinaceous purple to dark slate violet.

Potato plug : Plug covered with a dense growth of cottony mycelium, which was at first white to shell pink, or flesh pink and buff pink where it touched the glass. Later there were flecks of dark delft blue in the mycelium at the base of the plug, or patches of dusky green blue to slate violet against the glass. In some cases, after 4 weeks, the mycelium was collapsed, tough and wet-looking.

Melilotus stems : Stems clothed with a fairly copious mycelium, which was tomentose to sericeo-tomentose, or felt-like, white, tinged olive buff to ochre in the dryer parts. Occasionally a few minute, light pinkish cinnamon sporodochia developed (in one strain only).

Bean pod : Pod covered with a moderate growth of mycelium, which was white to olive buff, tomentose, or very coarsely sericeo-tomentose. After 4 weeks, the mycelium was collapsed and wet-looking.

Rice : Growth white to alizarine pink and old rose or bishop's purple, fa ling to dul purple. After 4 weeks the mycelium became collapsed and wet-looking. Cultures had a slight or fairly pronounced odour, resembling that of over-ripe apples. The odour is described by Reinking and Wollenweber (39) as " benzolic."

Measurements of Conidia.

Oat agar, culture 4 weeks old, conidia from mycelium. Conidia nearly a 0-septate a few 1–2-septate, 3–5-septate conidia rare.

0-septate	5–14 × 2·7–3·5.
1-septate	14–18 × 3–4.
2-septate	15–22 × 3·5–4.
3-septate	30–52·5 × 3–4·5.
4-septate	42·5–55 × 3·7–4·5.
5-septate	43–45 × 3·7–4·5.

Bean pod, culture 4 weeks old, conidia from pionnotes.

0-septate	60 per cent	5–15 × 2–3.
1-septate	3 ,,	10–22·5 × 2·5–3·5.
3-septate	26 ,,	25–47·5 × 3–3·75.
4-septate	1 ,,	45–50 × 3·7.

Oat agar, culture 4 weeks old, conidia from pionnotes.

5-septate	4 per cent	40–45 × 3·7.
4-septate	13·5 ,,	37·5–50 × 3·5–4.
3-septate	75·5 ,,	30–47·5 × 2·5–4.
1-septate	1·5 ,,	
0-septate	5·5 ,,	

In pionnotes there were occasionally 80–90 per cent. of 3-septate conidia ; conidia from mycelium were usually about 99 per cent. microconidia.

Chlamydospores terminal and intercalary, common in the mycelium, and occasionally seen in the macroconidia. Form and dimensions agreed with the particulars given in the general description.

Fusarium angustum Sherb.

Sherbakoff, New York (Cornell) Agric. Exp. Sta. Memoir 6 : 203, 1915. Wollenweber, Fusarium-Monographie, 410–411, 1931 ; Fus. aut. del. 365, 991–993. Wollenweber and Reinking, Die Fusarien. 113, 1935.

Syn. *Fusarium sclerostromaton* Sideris.

Stroma plectenchymatous, effuse, pink to purple. Aerial mycelium more or less abundant, white or tinged with the colour of the colour of the stroma, sometimes flecked with delft blue or with green-blue patches. Conidia borne on the mycelium or in a thin pionnotes, pinkish cinnamon in mass, or stained with the colour of the stroma. Conidia elongated, almost cylindrical, straight or slightly curved, tapering at both ends, sometimes curved in more than one direction.

0-septate	5–18 × 2–3·5	Average 11 × 2·6.
1-septate	12-24 × 2·5–4	Average 21 × 3.
3-septate	29-69 × 2·5–4·7	Average 45·6 × 3·5.
5-septate	43-81 × 3·5–4·7	Average 60 × 4·2.
6–8-septate	70–102 × 4–4·7	Average 78 × 4.

Chlamydospores 1-celled, 6–13 μ diam., or 2-celled, 13–18 × 6–10.

Hab. *Arachis hypogaea* L., from pods and seeds decaying while still in the soil. University Farm, Pretoria, 1932 (F. du Toit).

Citrus limonia Osbeck, from lemons decaying after 6 weeks in storage ; fruit from Sunday's River, Cape.

From roots of rough lemon stock on which orange or grape fruit had been budded roots, showing " dry root rot " Zebediela, N. Transvaal, M.H.

28432 and 28441 ; Elizabethville, Belgian Congo ; Steenbokfontein, Rustenburg dist., Transvaal, M.H. 28427 ; Marikana, Rustenburg dist., M.H. 28426 ; Acornhoek, E. Transvaal ; Bonnievale, Cape.

From soil in citrus orchards, Kosterfontein, Marico dist., M.H. 28427 ; Boskoppies, nr. Rustenburg.

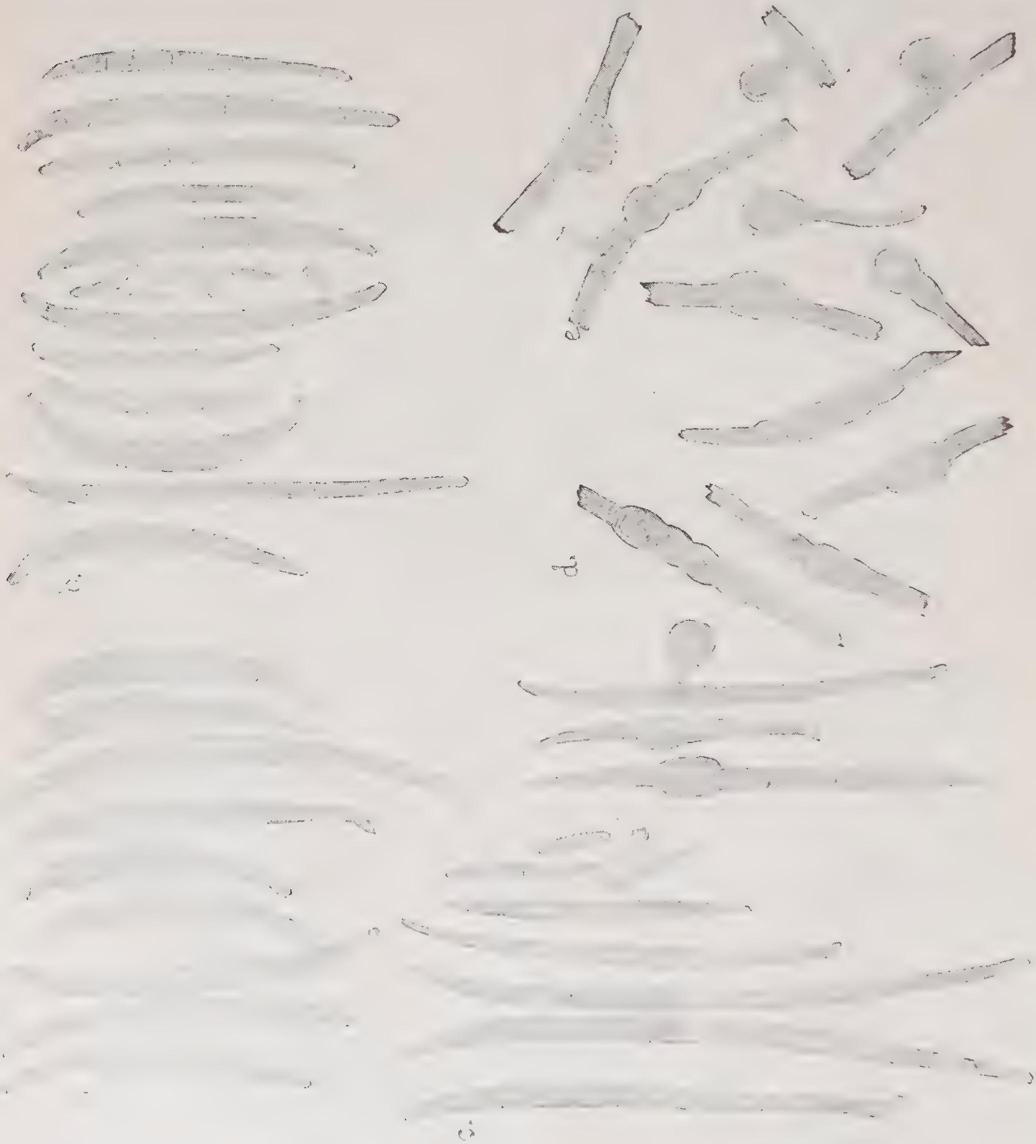

Fig. 25.

Fusarium angustum Sherb. ; conidia from thin pionnotes of 4 weeks old cultures on (*a*) hard potato agar, (*b*) oat agar, and (*c*) standard synthetic agar plus starch, (*d*) chlamydospores from culture on hard] potato agar.

Citrus sinensis Osbeck, from fruit showing stem end rot, after 6–18 weeks in storage; from Valencia oranges from White River, Zebediela and Rustenburg, Transvaal; from navel oranges from Zebediela, White River and Letaba, Transvaal, from Groot Drakenstein, Cape, and from Muden, Natal. (23 isolations from oranges in all).

From roots of old seedling orange tree, Villiersdorp, Cape.

Gossypium sp., from stem of wilting plant, (associated with *Phoma* sp.), Rustenburg (Moore).

Lycopersicum esculentum Mill., from rotting petioles, Gqaga, Transkei (ass. *F. sambucinum*); from stems of plants wilting from attack of *Bacterium solanacearum*, Tonetti, E. Transvaal (Wager).

Medicago sativa L., from discoloured tissue of crown of dying plant, Pietersburg, Transvaal.

Pinus sp., from wood with intense yellow discolouration, Hogg's Back, Cape (Lurie).

Polygala virgata Thun., from stem wilting plant, Durban (McClean).

Growth on Standard Media.

Oat agar: Aerial mycelium sparse, consisting of a fringe of white hyphae at the top of the slant. Growth on substratum pale to dull Indian purple. Pionnotes formed on the lower half of the slant; they were light pinkish cinnamon, or were tinged vinaceous purple, through absorption of the colour of the stroma. In some of the strains from *Citrus*, pionnotes were produced more freely over the surface of the slant on this medium and on other media.

Hard potato agar: Aerial mycelium sparse, cottony, white or faintly tinged vinaceous lavender. Growth on substratum colourless. Pionnotes formed on the lower half of the slant; they were light pinkish cinnamon.

Standard synthetic agar plus starch: Aerial mycelium present in patches, tomentose to felt-like, white to vinaceous lilac. Growth on substratum dull Indian purple to vinaceous lilac. Pionnotes light pinkish cinnamon, or tinged vinaceous lilac.

Potato agar plus 5 *per cent. dextrose:* Aerial mycelium in patches, tomentose to matted, white to vinaceous lilac. Growth on substratum dull Indian purple.

Potato plug: Plug covered with a fairly plentiful fine mycelium, which was cottony to felt-like, and white, tinged seashell pink or deep vinaceous lilac. In some tubes the mycelium was flecked with deep delft blue, or there were patches of dark glaucous grey to green blue slate, especially between the medium and the glass.

Melilotus stem: Stems covered with a moderate growth of mycelium, which was white, or tinged chamois to yellow ochre in places, and cottony to sericeo-tomentose. Pinkish cinnamon pionnotes sometimes formed on the moister parts of the medium.

Bean pods: Aerial mycelium moderate in amount, tomentose to matted, white, or with patches of chamois or yellow ochre. Mycelium became collapsed and wet-looking after 4 weeks.

Rice: Growth white to alizarine pink and acajou red, or sometimes carmine. After 8 weeks, the colour had faded to nigrosin violet.

Measurements of Conidia.

Hard potato agar, culture 12 days old, conidia from pionnotes.

8-septate	Rare	72–90 × 4–4·7.
7-septate	1 per cent	67·5–85 × 4–4·7.
5-septate	2 ,,	50–82·5 × 4–4·5.
4-septate	2 ,,	50–74 × 3–4·5.
3-septate	83 ,,	47·5–72·5 × 3–4·5.
2-septate	1 ,,	35–40 × 3–3·75.
1-septate	3 ,,	20–32 × 2·5–3·75.
0-septate	8 ,,	10·5–17·5 × 2–3·75

Standard synthetic agar plus starch, culture 4 weeks old, conidia from pionnotes.

6–7-septate	Rare	67·5 77·5 × 3·7–4·7.
5-septate	1·5 per cent	52·5–80 × 3·7–4·4.
4-septate	0·5 ,,	50–77·5 × 3–4·4.
3-septate	17 ,,	32·5–62·5 × 3 3·75.
2-septate	4 ,,	27·5–45 × 2·5–3·1.
1-septate	20 ,,	12·5–20 × 2·8–3.
0-septate	57 ,,	5–15 × 2–3.

Chlamydospores formed in mycelium and conidia. Mycelial chlamydospores mostly erminal, at the ends of long slender hyphae, single or in pairs, rugulose ; single chlamyospores from 4 weeks old culture on hard potato agar, 7·5–10 μ diam.

Fusarium conglutinans Wr. var. **callistephi** Beach.

Beach, The Fusarium wilt of china aster, Mich. Acad. Sci. Rept. 20 : 281–308, 1918. Wollenweber, Fusarium-Monographie, 407–408, 1931 ; Fus. aut. del. 619, 980, 981. Wollenweber and Reinking, Die Fusarien, 110–111, 1935.

Syn. *Fusarium conglutinans* v. *majus* Wr.

Stroma pale, white, then yellowish, brownish, or pinkish-white, exceptionally with traces of grey lilac. Microconidia scattered, or occasionally covering the substratum with a thin pionnotes, mostly 1-celled, seldom 1-septate, interspersed more or less freely with larger 3–5–7-septate conidia. Macroconidia cylindrical-fusiform, or somewhat curved.

0-septate	5–13 × 2–3·5	Mostly 6–10 × 2·2–3.
1-septate	11–20 × 2·2–4	Mostly 13–19 × 2·5–3·5.
3-septate	23–55 × 3–4·5	Mostly 28–46 × 3–4·4.
5-septate	32–60 × 3–4·5	Mostly 40–54 × 3·5–4.
7-septate	51–71 × 3–4·5	Average 59 × 3·7.

Chlamydospores numerous, terminal and intercalary, spherical to pyriform, 1–2-celled, also in short chains and small clusters, smooth or rugulose. Sporodochia and sclerotia wanting.

This variety is the cause of wilt in asters, (*Callistephus chinensis*), and occurs in all countries where asters are cultivated, except in those with comparatively low summer temperatures.

Hab. *Callistephus chinensis* Nees, from discoloured stems of wilting plants. Pretoria (Doidge, Wager, van der Merwe) M.H. 28437, and Durban (McClean and Anderson). Ten isolations were studied. The organism is probably widely distributed in the Union.

Growth on Standard Media.

Oat agar : Aerial mycelium sparse, white, cottony. Growth on substratum colourless, or becoming tinged light congo pink. The pink colour faded after 4 weeks, and was replaced by a tilleul buff or brownish tinge.

Hard potato agar : Aerial mycelium sparse, white, cottony, mostly at the top and bottom of the slant. Growth on substratum colourless. A thin pionnotes formed on the surface of the slant.

Standard synthetic agar plus starch : Aerial mycelium like that on hard potato agar. Growth on substratum colourless, or with a faint tinge of flesh pink ; occasionally there was a tinge of dark vinaceous grey in the agar under the lower part of the slant. A thin pionnotes developed along the needle track.

Potato agar plus 5 per cent. dextrose : A moderate amount of aerial mycelium developed, especially on the lower half of the slant. Growth in the substratum was white, shining, or tinged light brown vinaceous and dark bluish grey green.

Potato plug : Plug covered with a vigorous, white, cottony mycelium.

Melilotus stem : Stems covered with a copious, white, cottony mycelium, or with a less vigorous growth which was tomentose to sericeo-tomentose and brownish white.

Bean pod : Pods covered with a fairly vigorous growth of white, cottony, aerial mycelium. It occasionally became tinged with yellow or with light pinkish cinnamon.

Rice : Growth white, or very faintly tinged sea-shell pink. Grains cream colour to cream buff.

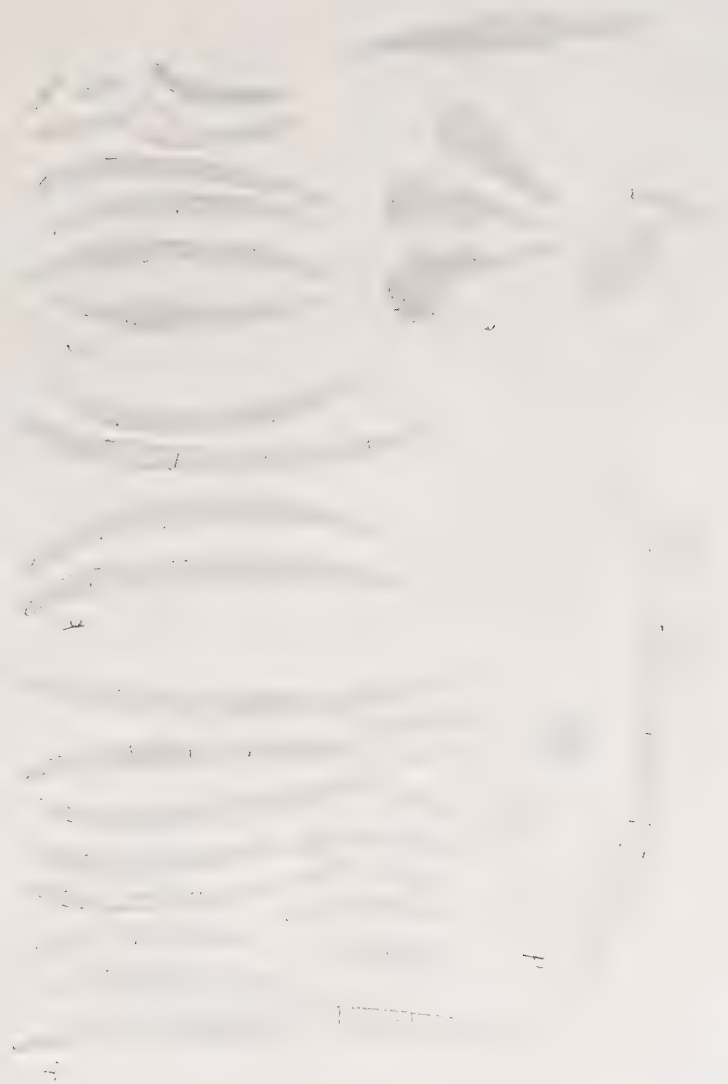

Fig. 26.

Fusarium conglutinans Wr. v. *callistephi* Beach ; Conidia from thin pionnotes of (*a*) 8 weeks old culture on standard synthetic agar plus starch, (*b*) 2 weeks old culture on oat agar, (*c*) 4 weeks old culture on hard potato agar ; chlamydospores from (*d*) 5 days old culture on plain agar and (*e*) 4 weeks old cultur eon hard potato agar.

Measurements of Conidia.

Oat agar, culture 2 weeks old, conidia from thin pionnotes.

5-septate	2 per cent	32·5–52·5 × 3·5–4·5.
4-septate	2 ,,	32·5–40 × 2·8–3·75.
3-septate	28 ,,	22·5–45 × 2·8–3·75.
2-septate	7 ,,	25–32 × 2·5–3.
1-septate	6 ,,	10–27·5 × 2·5 3.
0-septate	55 ,,	7·5–15 × 2–2·8.

Standard synthetic agar plus starch, culture 2 weeks old, conidia from thin pionnotes.

5-septate	4·5 per cent	55–80 × 3·7–4·5.
4-septate	0·5 ,,	55–70 × 3·5–4.
3-septate	2 ,,	40–67·5 × 3–4.
2-septate	1·5 ,,	
1-septate	3·5 ,,	
0-septate	89 ,,	

Most of the conidia from the mycelium were non-septate, those which were 3- or more septate being only about 1 per cent. of the whole number. A few conidia with more numerous septations were observed amongst these, especially on hard potato agar and standard synthetic agar plus starch. The measurements of these were as follows.

6-septate	50–75 × 3·7–4.
7-septate	50–75 × 3·7–4·5.
8–11-septate	55–75 × 3·7–4·5.

Chlamydospores numerous, thick-walled, rough; intercalary single and in pairs 7–9 μ diam.; terminal usually single, 7·5–12·5 μ diam.

Sub-section CONSTRICTUM.

Sporodochia and pionnotes present. Macroconidia elongated, slender, 3–3·7 μ diameter, rather more curved at the ends than at the middle, apex constricted, base pedicellate, 3–1 or 3–5-septate; the 3-septate 10–13 times, and the 5-septate 13–15 times as long as broad. Chlamydospores, sclerotia and sclerotial stromata as in sub-section *Orthocera*.

Fusarium Bulbigenum Cke. et Mass.

Cooke and Massee, Grevillea 16: 49. 1887. Wollenweber, Fusarium-Monographie, 411–412, 1931; Fus. aut. del. 367–370, 372, 374, 994, 995, 997, 999. Wollenweber and Reinking, Die Fusarien, 113–114, 1935.

Syn. *Fusarium cromyophthoron* Sid.;

F. loncheceras Sid.; *F. loncheceras* v. *microsporon* Sid.

F. rhizochromatistes Sid.; *F. rhizochromatistes* v. *microsclerotium* Sid.

F. laxum Peck; ? *F. equisetorum* (Lib.) Desm.; *Hymenula equiseti* Lib.

Stroma sometimes effuse, plectenchymatous, pale, or pink to violet red, covered with pinkish white or lilac, aerial mycelium; sometimes rugulose, sclerotially erumpent, and developing hard sclerotial bodies 0·5–5 mm. in diameter, which are from light brownish white or green to dark blue in colour. Conidia in sporodochia, on a flat or raised stroma, or formed directly on the substratum, or in a pionnotal layer; ochre to salmon colour in mass. Chlamydospores terminal or intercalary, single, 2-celled or in chains, 5–12 μ diam. Microconidia 1-celled, or with 1 or 2 septations; macrocondia 3 5-septate, elongated, subulate, straight or sub-falcate, tapering at both ends; somewhat constricted at the apex, and abruptly bent, or symmetrical and acute; base more or less pedicellate.

0-septate	5–12 × 2–3·5	Mostly 7–9 × 2–3.
1-septate	11–33 × 2–3·7	Mostly 13–20 × 2·3–3·2.
3-septate	20–54 × 2·3–4	Mostly 34–44 × 2·7–3·9.
5-septate	34–66 × 3–4·5	Mostly 45–56 × 3·2–3·9.

Hab. *Allium cepa* L., from bulb of wilting plant, Eikenhof, nr. Johannesburg, Oct. 1932, M.H. 28362.

FIG. 27.

Fusarium bulbigenum Cke. et Mass.; (*a-d*) strain from onion, (*e-f*) strain from tobacco; conidia from sporodochia of (*a*) 10 weeks old culture on standard synthetic agar plus starch, (*b*) 4 weeks old culture on oat agar, (*c*) 8 weeks old culture on Melilotus stem, (*d*) chlamydospores from culture on hard potato agar, 8 weeks old; conidia on mycelium of culture (*e*) 8 weeks old on potato agar plus 5 per cent. dextrose, (*f*) 12 weeks old on standard synthetic agar plus starch, (*g*) 4 weeks old on Melilotus stem, and (*h*) 4 weeks old on oat agar.

Freesia refracta Klatt., from corms showing a form of dry rot, said to develop in storage, Pretoria, 1929.

Gladiolus sp., from corms of indigenous species of *Gladiolus* showing dry, brown form of rot when dug up in veld, Palmaryville, nr. Louis Trichardt, N. Transvaal (Koker).

Nicotiana tabacum L., from discoloured vascular tissues of stems and petioles of wilting tobacco plants (7 isolations), Rustenburg, Transvaal (Moore).

From soil; isolated from a soil sample by Dr. Kammerman, Division of Chemistry. This strain was extremely tolerant of copper sulphate; it grew in concentrations of 1/750 and 1/1000; growth was inhibited by 1/500.

Fusarium bulbigenum occurs in Europe, and less frequently in America on decaying bulbs, tubers, rhizomes, roots, stems, fruit, etc., chiefly on plants belonging to the Liliiflorae, but also on other hosts. It is also present in humus.

Growth on Standard Media.

Oat agar: Aerial mycelium sparse or plentiful; in the latter case it is dense, matted, white to vinaceous pink. Growth on substratum purplish vinaceous, or vinaceous purple to dull Indian purple. Very numerous, blue-black, rough, irregular sclerotial outgrowths appeared in some strains after 4 weeks, pushing through the aerial mycelium, and becoming more or less erect and stilboid. Groups of sporodochia developed on the stroma at the base of the tube; they were 2–3 mm. diam., and pale pinkish cinnamon.

Hard potato agar: Mycelium sparse to moderate in amount, white, tomentose or matted. Growth on substratum colourless. A few small sporodochia developed; they were light ochraceous salmon. A number of minute, blue-black sclerotia developed at the base of the slant.

Standard synthetic agar plus starch: Aerial mycelium short, sparse, tomentose. Growth on substratum coral pink to vinaceous pink, with groups of blue-black, erumpent, sclerotial bodies near the base of the slant; or growth in substratum anthracene purple to taupe brown, and the agar stained the same colour. Groups of pale pinkish cinnamon sporodochia developed after 5 weeks.

Potato agar plus 5 *per cent. dextrose:* Aerial mycelium rather dense, coarse, tomentose or matted, white to slate purple. Growth on substratum dark perilla purple and dark naphthalene violet, or almost black, and the agar stained the same colour.

Potato plug: Plugs covered with a dense mycelial growth, which was cottony to tomentose, and white to sea-shell pink. Very numerous blue-black sclerotial bodies developed after 5 weeks; these were scattered, or crowded and coalescent; in the latter case, they formed larger sclerotial masses up to 3·5 mm. diam. Sporodochia developed on the sclerotial masses.

Melilotus stem and bean pod: Medium covered with rather sparse mycelium, which was short and felt-like, or sericeo-tomentose, white to pinkish buff. Colourless sclerotial bodies developed in places, and on these the pale pinkish cinnamon sporodochia formed.

Rice: Mycelium fairly dense, white to flesh colour, venetian pink and old rose; mycelium on grains was often eugenia red to acajou red.

Measurements of Conidia.

A.—Strain from *Allium*.

Oat agar, culture 8 weeks old, conidia from sporodochia.

5-septate............	10 per cent..........	37·5–55 × 3·75–4·5.
4-septate............	39 ,, ...	30–47·5 × 3·5–4.
3-septate............	49 ,, ...	25–45 × 3–3·75.
1-septate............	1 ,, ...	10–18 × 2·5–3·5.
0-septate............	1 ,, ...	7–9 × 2–3.

Standard synthetic agar plus starch, culture 8 weeks old, conidia from sporodochia.

5-septate............	8 per cent........	37·5–50 × 3·7–4·5.
4-septate............	14·5 ,, ...	38–52 × 2·5–4·5.
3-septate............	77·5 ,, ...	30–49 × 2·5–3·75.

Melilotus stem, culture 8 weeks old, conidia from sporodochia.

4-septate............	4 per cent..........	27·5–42·5 × 3·5–4·5.
3-septate............	92 ,, ...	26–42·5 × 3·7–4·5.
0-septate............	4 ,,	

Chlamydospores formed freely on plain agar plates; they were terminal or intercalary smooth or verrucose, 5–10 μ diam.

B.—Strain from *Nicotiana*.

Hard potato agar, culture 8 weeks old, conidia from pionnotes.

7-septate............	Rare.................	42·5 × 4.
6-septate............	2 per cent........	42·5–47·5 × 3·7–4·25.
5-septate............	7 ,, ...	36–57·5 × 3–4·25.
4-septate............	12 ,, ...	37·5–47·5 × 3·5–4.
3-septate............	19 ,, ...	20–42·5 × 3–4.
2-septate............	0·6 ,, ...	22–25 × 2·5–3.
1-septate............	9 ,, ...	14–30 × 2·5–3·25.
0-septate............	50·5 ,, ...	7·5–12·5 × 2–3.

Oat agar, culture 6 weeks old, conidia from mycelium. Very few macroconidia, possibly 0·1 per cent. to 0·5 per cent.

6–7-septate............	75–80 × 4–4·5.
5-septate............	35–72·5 × 3–4·25.
4-septate............	30–70 × 3·5–4.
3-septate............	20–55 × 3–4 (about 50 per cent. of the macroconidia).
2-septate............	20–30 × 2·5–2·8.
1-septate............	15–27·5 × 2·5–2·8.

Standard synthetic agar plus starch, culture 10 weeks old, conidia from sporodochia.

8-septate............	1 per cent........	76–80 × 4–4·5.
7-septate............	1·5 ,, ...	72·5–75 × 4–4·5.
6-septate............	7 ,, ...	47·5–75 × 3·7–4·25.
5-septate............	58·5 ,, ...	40–75 × 3·5–4·25.
4-septate............	18·5 ,, ...	20–57·5 × 3·5–4·25.
3-septate............	10·5 ,, ...	19–48 × 3–4.
1-septate............	0·5 ,, ...	17·5 × 2·5.
0-septate............	2·5 ,,	

Melilotus stem, culture 6 weeks old, conidia from mycelium.

Very few macroconidia, about 0·1 per cent.; about 50 per cent. of these were 3-septate.

5-septate..................................	45–77·5 × 2·8–4.
4-septate..................................	45–65 × 2·5–4.
3-septate..................................	28–55 × 2·8–3·75.
2-septate..................................	25–32 × 2·5–2·8.
1-septate..................................	15–22·5 × 2·5–3.

The conidia of the strain from tobacco seem to be longer on the average than those of typical *Fusarium bulbigenum*, and in sporodochia and pionnotes there were sometimes over 50 per cent. of 5-septate conidia. Chlamydospores mostly terminal, single or occasionally in pairs, 5–12 μ diam.

Should further study show that this fungus is a specific vascular parasite of tobacco, it may then be regarded as a distinct variety, but for the present it must be classified as *F. bulbigenum*.

Fusarium bulbigenum Cke. et Mass. var. **lycopersici** (Brushi) Wr. et Rkg.

Wollenweber and Reinking, Die Fusarien, 114–115, 1935. Wollenweber, Fusarium-Monographie, 412, 1931; Fus. aut. del. 393, 996, 998.

Syn. *Fusarium lycopersici* Brushi.

F. oxysporum Schl. *f. lycopersici* Roum.

F. oxysporum Schl. v. *lycopersici* Lindau.

F. oxysporum Schl. subsp. *lycopersici* Sacc.

F. bulbigenum Cke. et Mass. *f.* 1 Wr.

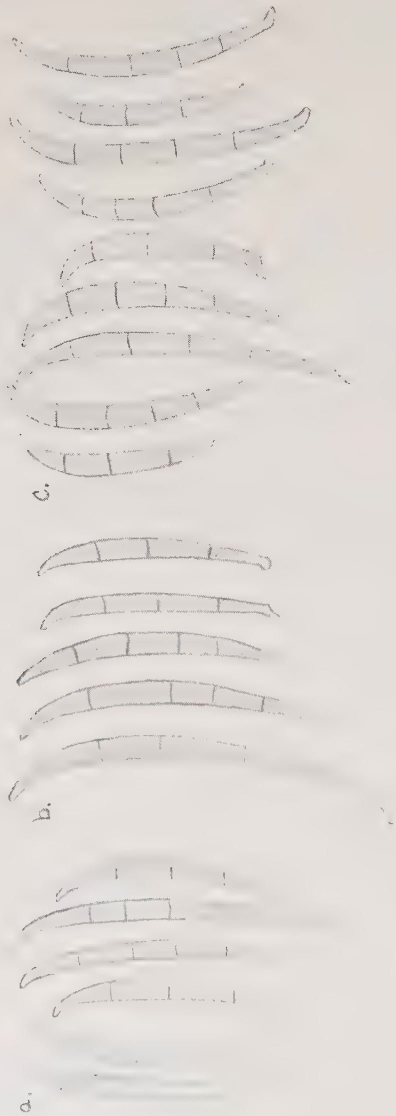

Fig. 28.

Fusarium bulbigenum Cke. et. Mass. v. *lycopersici* (Brushi) Wr. et. Rkg.; conidia from (*a*) pionnotes on 12 weeks old culture on standard synthetic agar plus starch, (*b*) pionnotes of 6 weeks old culture on hard potato agar, (*c*) sporodochia of oat agar culture, 6 weeks old.

This variety differs from the type in the absence of pigment in the sclerotially erumpent stroma, which never becomes blue. Aerial mycelium floccose, white or pinkish white. Plectenchymatous stroma violet red or pale; sclerotial stroma colourless, smooth, flat, later disappearing. Sporodochia minute, raised, often coalescing more or less to form a pionnotes; conidia in mass flesh pink to light orange. Microconidia 1-celled, or with 1–2-septations, produced freely on the aerial mycelium. Macroconidia 3–5-septate, seldom 6–7-septate.

0-septate............	8 × 2·5.	
1-septate............	18 × 2·8.	
3-septate............	25–66 × 2·3–4·3.....	Mostly 31–50 × 2·8–3·8.
5-septate............	32–68 × 2·8–4·5.....	Mostly 43–56 × 3–4.
7-septate............	50–70 × 3–4·5.......	Average 56 × 3·9.

Chlamydospores terminal and intercalary, typical.

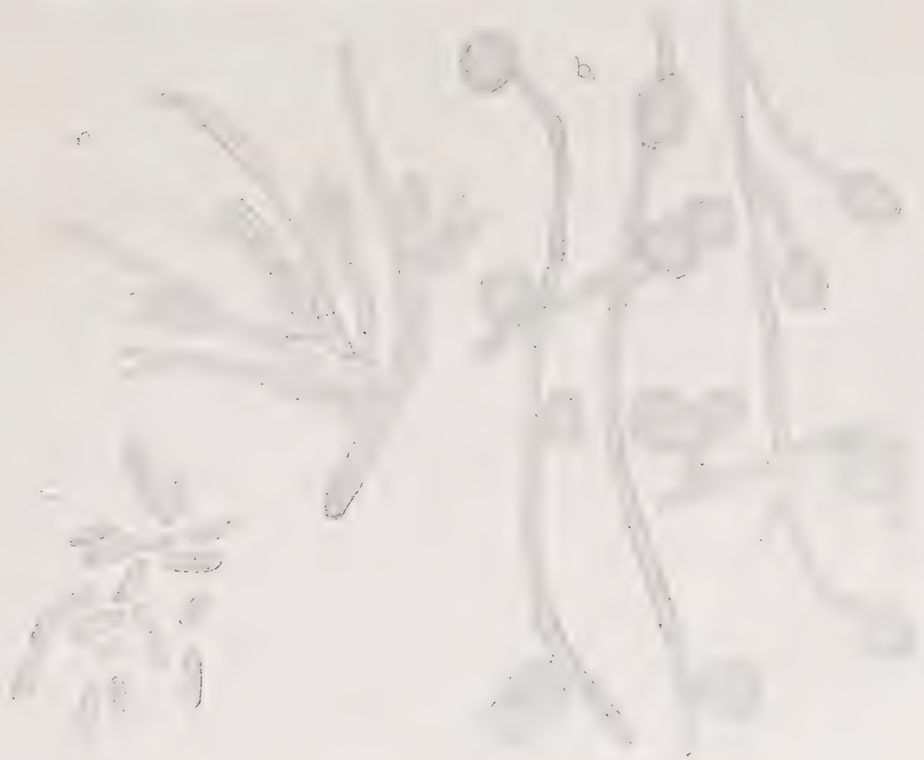

Fig. 29.

Fusarium bulbigenum Cke. et Mass. v. *lycopersici* (Brushi) Wr. et Rkg.; (*a*) part of branched conidiophore from sporodochium of culture on potato plug, (*b*) chlamydospores and (*c*) microconidia from 8 weeks old culture on standard synthetic agar plus starch.

Hab. *Lycopersicum esculentum* Mill., very common as a cause of wilt of tomato plants, especially in the Eastern Transvaal: numerous isolations studied from stems of wilting plants: Nelspruit, Karino and Boulders, E. Transvaal (Wager) M.H. 28128; from petioles of wilting plants, Gqaga, Transkei (Wager): from fruits taken from wilted plant, Duivelskloof, N. Transvaal (Wager); from seed offered for sale by local seedsmen (found in 5 samples; most of the seed used by commercial growers is imported from America).

Carica papaya L., from base of stem of plant affected by foot rot, Buffelspoort, Rustenburg Dist.

Citrus sinensis Osbeck, from fruit externally sound, but showing centre rot, after 17 weeks in storage; navel orange from Letaba, N. Transvaal (only one isolation).

Dianthus caryophyllus L., from discoloured stems of plants collapsing as a result of foot rot, Pretoria (Doidge) M.H. 28391.

Fusarium bulbigenum v. *lycopersici* is a cause of tomato wilt, and occurs chiefly in North America. It occurs on other plants under humid conditions, and has been proved, by artificial inoculation, to be injurious to *Allium*, *Freesia*, *Medicago*, *Pyrus malus* and *Trifolium*.

Growth on Standard Media.

Oat agar: Aerial mycelium sparse, white tinged vinaceous lilac, or rather copious matted, white to hydrangea pink. Growth on substratum vinaceous lilac and orange vinaceous to vinaceous purple and deep purplish vinaceous. Pionnotes developed on the surface of the slant, or sporodochia were formed on small, pale, sclerotial outgrowths. Conidia in mass ochraceous buff to ochraceous salmon or apricot buff.

Hard potato agar: Aerial mycelium sparse or copious, white, cottony. Growth on substratum colourless. Pionnotes developed after 14 days, mostly along the needle track; they were pinkish cinnamon.

Standard synthetic agar plus starch: Aerial mycelium very scant, white to vinaceous lilac, cottony. Growth on substratum colourless to congo pink or vinaceous purple. In some cultures a rather sparse pionnotes developed, and in others light congo pink sporodochia.

Potato agar plus 5 *per cent. dextrose:* Aerial mycelium fairly abundant, white to vinaceous lilac; growth on substratum dull Indian purple. In some cultures the agar under the slant was stained purplish vinaceous to dark vinaceous.

Potato plug: Aerial mycelium abundant, white to sea-shell pink and pale salmon cottony to arachnoid, or dense, matted and becoming wrinkled and felt-like. Growth on substratum tinged purplish lilac and hyssop violet. In some cultures, sporodochia developed on small, colourless sclerotial outgrowths.

Melilotus stem: Mycelium moderate in amount, white to dirty white, or tinged ochre in the dryer part of the medium, tomentose to sericeo-tomentose. A few light ochraceous salmon sporodochia sometimes developed.

Bean pod: Aerial mycelium moderate to copious, sericeo-tomentose, or tending to become wrinkled and felt-like, white or dirty white to light pinkish cinnamon. A few colourless sclerotial bodies developed.

Rice: Aerial mycelium white to chatenay pink, becoming flesh pink and coral pink. Growth on grains vinaceous to deep vinaceous, then eugenia red to acajou red. After 4 weeks, there was sometimes a tinge of purplish lilac near the bottom of the tube, and there were colourless masses of plectenchyma between the medium and the glass.

In several strains, including at least one which was proved to cause wilt in tomatoes, a few minute, dark delft blue sclerotia, or patches of dark delft blue plectenchyma appeared in cultures when the organism was newly isolated. These did not reappear in subsequent sets of cultures.

Measurements of Conidia.

Standard synthetic agar plus starch, culture 8 weeks old, conidia from sporodochia.

5-septate............	2·5 per cent........	45–57 × 3–4.
4-septate............	15·5 ,, ...	40–52·5 × 3·5–4.
3-septate............	71·5 ,, ...	25–45 × 2·5–3·75.
2-septate............	3·5 ,, ...	22·5–32·5 × 2·5–3·5.
1-septate............	1·5 ,, ...	15–22·5 × 2·5–3·5.
0-septate............	5·5 ,, ...	7·5–15 × 2·5–3·75.

Oat agar, culture 6 weeks old, conidia from sporodochia.

5-septate............	2·5 per cent........	40–55 × 3·5–4.
4-septate............	9 ,, ...	35–50 × 3·5–4.
3-septate............	82 ,, ...	20–52·5 × 3–4.
2-septate............	2·5 ,, ...	15–22 × 3–3·5.
1-septate............	3 ,, ...	10–20 × 3–3·5.
0-septate............	1 ,, ...	5–10 × 2·5–3·5.

Hard potato agar, culture 8 weeks old, conidia from pionnotes.

6-septate............	0·5 per cent........	45–62·5 × 4–4·5.
5-septate............	2 ,, ...	50–57·5 × 3–3·75.
4-septate............	8 ,, ...	45–52·5 × 3·75.
3-septate............	52·5 ,, ...	30–52·5 × 3–3·75.
2-septate............	3·5 ,, ...	25–30 × 3–3·75.
1-septate............	7·5 ,, ...	15–25 × 2·5–3.
0-septate............	26 ,, ...	7·5–17·5 × 2–3.

Hard potato agar, culture 2 weeks old, conidia from pionnotes.

9–10-septate............	Rare................	70–75 × 4–4·5.
6–8-septate............	Rare................	45–57·5 × 4–4·5.
5-septate............	1·5 per cent........	45–60 × 3·5–4·5.
4-septate............	3·5 ,, ...	45–60 × 3·5–4·5.
3-septate............	87 ,, ...	25–50 × 3·5–4·5.
2-septate............	2 ,, ...	20–25 × 3·5–4.
1-septate............	3 ,, ...	12·5–20 × 3–3·7.
0-septate............	4 ,, ...	6–10 × 2·5–3.

A few conidia with 7–10-septations were also observed in pionnotes on plain agar, and on standard synthetic agar plus starch, 10-septate up to 90 μ long, 7–9-septate 60–85 μ long. Chlamydospores intercalary or terminal, single or in pairs, round or pyriform, 5–10 μ diameter.

Fusarium bulbigenum Cke. et Mass. var. **niveum** (E. F. Sm.) Wr.

Wollenweber, Fusarium-Monographie, 414–415, 1931; Fus. aut. del. 387, 1002, 1169. Wollenweber and Reinking, Die Fusarien, 117, 1935.

Syn. *Fusarium niveum* Erw. F. Sm.; *F. citrulli* Taub.

F. Poolensis Taub.; *F. vasinfectum* Ferr. (non Atk.)

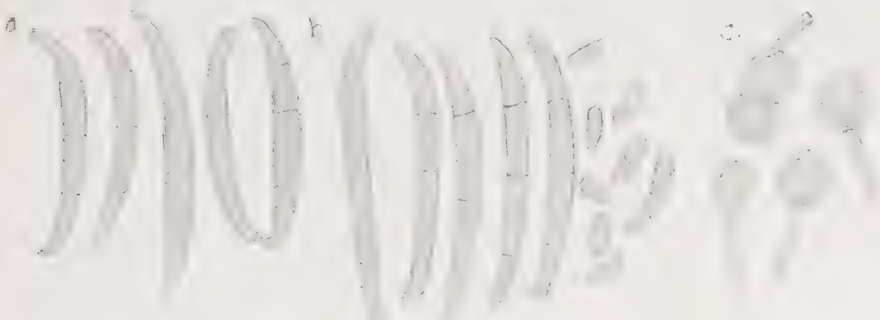

FIG. 30.

Fusarium bulbigenum Cke. et Mass. v. *niveum* (E. F. Sm.) Wr.; conidia from mycelium of 4 weeks old culture on (*a*) standard synthetic agar plus starch, and (*b*) oat agar.

Conidia somewhat broader than those of the type, and the colour of the effuse stroma is a deeper purple. Mycelium white, flesh colour, pink or purple. Stroma sometimes sclerotially erumpent, dark blue. Sclerotial bodies comparatively large, up to 3–6 mm.

diam., occurring infrequently, and disappearing or becoming colourless when the organism has been growing for some time in culture. Microconidia 1-celled, or with 1–2-septa, straight or curved, formed freely in the aerial mycelium. Macroconidia in sporodochia and pionnotes, light red orange in mass, 3–5-septate, elongated, almost cylindrical to fusiform-falcate, tapering at both ends; apex somewhat constricted, abruptly bent or conical; base truncated, conical or pedicellate.

0-septate............	$5–12 \times 2–4·5$........	Mostly $6·7–11 \times 2·2–3·3$.
1-septate............	$10–24 \times 2·5–5$.......	Mostly $12–18 \times 2·7–3$.
3-septate............	$24–50 \times 2·4–7$.......	Mostly $29–40 \times 3·1–4$.
5-septate............	$40–66 \times 3–5$.........	Mostly $43–56 \times 3·4–4·3$.

Chlamydospores typical, terminal and intercalary, spherical or oval, smooth; in conidia 5–10 μ diam., or if 2-celled $12–15 \times 7$; in mycelium larger, $7–21 \times 6–17$, 2-celled $15–30 \times 9–20$.

Hab. *Citrullus vulgaris* Schrad., from stems of wilting plants, Witpoort, P.O. Halfway House, Pretoria dist., 1931–1937; Biesjesvlei, Lichtenburg, Dec. 1935; Uitenhage, Cape (Haines).

This organism is known as the cause of a vascular wilt of watermelons, and possibly also of musk melons and cucumbers in the United States and less frequently in Europe. Watermelon wilt and its causal organism cause serious losses in fields where watermelon is a commercial crop in parts of South Africa. The large number of strains isolated varied considerably in culture characters, and also in the degree of pathogenicity to the host.

Growth on Standard Media.

Oat agar: Aerial mycelium moderate in amount, cottony to tomentose, white or faintly tinged with the colour of the stroma. Growth on substratum colourless, or vinaceous lilac to anthracene purple; sometimes with a touch of eugenia red at the top of the slant.

Hard potato agar: Mycelium rather sparse to moderate, white, or tinged pale mauve to manganese violet. Growth on substratum colourless.

Standard synthetic agar plus starch: Aerial mycelium sparse, cottony to tomentose, white or tinged with the colour of the stroma. Growth on substratum colourless to Hay's lilac or dark perilla purple; in the latter case, the agar was stained dusky dull violet; occasionally there were patches of deep delft blue in the substratum.

Potato agar plus 5 per cent. dextrose: Mycelium moderate in amount, tomentose, white to brownish vinaceous, vinaceous lilac and deep purplish vinaceous. Growth on substratum colourless to slate purple and anthracene purple, sometimes with a line of slate violet at the base of the slant. Agar sometimes stained dusky dull violet.

Potato plug: Aerial mycelium copious, tomentose, or sparse, sericeo-tomentose, white to congo pink. Growth on substratum pale to flesh colour, with patches of slate violet between the medium and the glass. There was a line of deep delft blue at the base of the plug.

Melilotus stem and bean pod: Mycelium sparse to moderate, tomentose to sericeo-tomentose, white or tinged ochre.

Rice: Growth white to eugenia red and dark vinaceous or vinaceous lilac. Not aromatic.

Measurements of Conidia.

Six strains of this fungus were studied, but no conidial masses were observed in any of the cultures; macroconidia were produced in limited numbers on the mycelium, and their measurements fell within the limits indicated in the general description of the variety.

Sub-section OXYSPORUM.

Sporodochia and pionnotes present. Macroconidia comparatively stout, 3·7-4·7 μ thick, fusiform-falcate, curved, tapering gradually or abruptly at both ends, with rostrate, elongated or constricted apex, and more or less pedicellate base, 3- or 3–5-septate. The 3-septate conidia 7 times, and the 5-septate 9–10 times as long as broad. Chlamydospores 1-celled, 5–15 μ diam., 2-celled 10–14 × 4–8 μ. Sclerotia and sclerotial stromata pale, or green to blue-black.

Fusarium oxysporum Schlecht.

Schlechtendahl, Flora berol. 2 : 139, 1824. Wollenweber, Fusarium-Monographie, 416–418, 1931 ; Fus. aut. del. 378, 379, 1004–1008, 1170–1174. Wollenweber and Reinking, Die Fusarien, 117–118 1935.

Syn. *Fusarium candidulum* Sacc ; *F. elegans* App. et Wr. (nom. nud.)
F. mycophilum Sacc. ; *F. myosotidis* Cke.
F. opuntiarum Speg. ; *F. trifolii* Jacz.

Fig. 31.

Fusarium oxysporum Schlecht. ; conidia from sporodochia of culture on (*a*) Melilotus stem, 8 weeks old, (*b*) standard synthetic agar plus starch, 8 weeks old, (*c*) oat agar, 10 weeks old, (*d*) bean pod, 12 weeks old, (*e*) chlamydospores from 8 weeks old culture on Melilotus stem.

Stroma brownish-white to violet, plectenchymatous, smooth, effuse ; or sclerotially erumpent and forming hard bodies, which are pale, or wood green to blue black, more or less rugulose, 0·5–3 or 3–6 mm. diam. When the fungus grows under more humid conditions, the stroma is usually covered with a filamentous aerial mycelium of medium height. Later sporodochia develop, or, less frequently, pionnotes. Conidia 3– (4–5)-septate, fusiform-falcate, curved or almost straight, definitely or weakly pedicellate. Microconidia 1–2-celled, oval to reniform, numerous, scattered in the mycelium, but lacking in typical sporodochia and pionnotes, which consist almost entirely of macroconidia.

0-septate............	5–15 × 2–4..........	Mostly 7–10 × 2·1–3.
1-septate............	10–26 × 2-4·5.......	Mostly 12–17 × 2·5–3·4.
3-septate............	19–45 × 2·5–5.......	Mostly 23–37 × 3–4·6.
5-septate............	30–60 × 3·5–5.......	Mostly 38–49 × 3·8–4·5.

Chlamydospores terminal and intercalary, in hyphae and conidia, spherical, smooth or rugulose, 1-celled, seldom 2-celled, 5–15 μ diam., sometimes larger in the mycelium (10–15). Hab. *Carica papaya* L., from stems of seedlings which were dying off, E. Transvaal (Wager) M.H. 28363.

Citrus sinensis Osbeck, from stem end rot and centre of fruit kept 12–18 weeks in storage; navel oranges from Sunday's River, and Groot Drakenstein, Cape, M.H. 28353, 28354 and 28351; and from White River, Transvaal; also from Valencia oranges, from Sunday's River and White River.

Coffea robusta L., from base of stem of plants which were not thriving, Hartebeestpoort, Transvaal (Koch) M.H. 28363.

Ipomoea batatas Lam., from tubers showing superficial, sunken, dry, discoloured areas, Humansdorp, Cape (Wager).

Lathyrus odoratus L., from decaying stems of seedlings, Brooklyn, Pretoria (Doidge).

Solanum tuberosum L., from tubers showing dry rot and wrinkling of stem end, Stamprietfontein, Windhoek, S.W.A.; Pretoria and Klerksdorp, Transvaal; Port Elizabeth, Cape; also in a consignment of potatoes from Hamburg, Germany; from tubers showing a soft type of rot, Mokeetsi, N. Transvaal, May 1931 (Wager); also reported by du Plessis (13) to have been isolated from potatoes from Paarl and Stellenbosch, Western Cape.

As defined by Wollenweber and Reinking (loc. cit.), this is a ubiquitous species, not a specific potato parasite, but occurring on an extensive range of hosts. It is known as a cause of rot of fruits, bulbs and tubers, but further investigations are necessary to determine its economic importance. It varies in the presence or absence of blue colouring in the sclerotial plectenchyma, and may, or may not produce on rice media a weak or strong aromatic odour, reminiscent of lilac. Morphologically the species is fairly constant with regard to the size, form and septation of conidia.

Growth on Standard Media.

Oat agar: Aerial mycelium very sparse. Growth on substratum tinged pale lilac to vinaceous purple. A few blue-black sclerotial masses, 2–5 mm. diam., formed near the base of the slant in some strains. Groups of sporodochia developed slowly. There was a pionnotal layer along the needle track after 14 days, but groups of sporodochia were not fully developed until after 4 weeks growth; they were pale to light vinaceous cinnamon, or shell pink to vinaceous pink.

Hard potato agar: A little sparse, white, arachnoid mycelium covered the slant. Growth on substratum colourless. Sporodochia small, cream colour to pale pinkish cinnamon. In one set of cultures, a few small sclerotia developed at the base of the slant.

Standard synthetic agar plus starch: Aerial mycelium very sparse, short and patchy, or wanting. Growth on substratum vinaceous pink to vinaceous lavender, later tinged slate purple. A few groups of small sporodochia developed, and somtimes coalesced along the needle track, to form a continuous pionnotal layer. Conidial masses were sea-shell pink to salmon buff or vinaceous pink. In some cultures one or two sclerotia formed at the base of the slant.

Potato agar plus 5 *per cent. dextrose:* Slant covered with a moderate growth of aerial mycelium, which was cottony or matted, felt-like, and becoming wrinkled; it was white to pale lilac and vinaceous lavender. Growth on substratum purplish vinaceous or dull Indian purple, sometimes becoming blue-black. The agar was often stained clove brown to almost black.

Potato plug: Plugs covered with a vigorous growth of cottony aerial mycelium, which sometimes became felt-like and wrinkled; mycelium white, tinged in places with light perilla purple. Sclerotial bodies very numerous, rough, minute to 5 mm. diam., at first pale, usually becoming blue-black; some strains produced no sclerotia on potato. Sporodochia vinaceous pink to light ochraceous salmon, developing in large groups; individual sporodochia 1–2 mm. diam.

Melilotus stem : Growth rather slow; after 14 days, stems were covered with a short, close, white mycelium. Sclerotia mostly small, or up to 2·5 mm. diam., few or numerous, scattered, remaining pale or becoming blue-black. Sporodochia began to develop after 14 days; they were 0·5–2 mm. in diameter, light pinkish cinnamon to light ochraceous salmon.

Bean pod : The pods were covered with a rather thin white mycelium, with scattered opaque spots, or with a heavier growth of white cottony mycelium. Groups of sporodochia were developing after 14 days; they were pinkish buff to light pinkish cinnamon and light ochraceous cinnamon. In some cultures there were numerous, minute, scattered, blue-black sclerotia.

Rice : Growth at first white to flesh pink, or laelia pink to tourmaline pink; after 14 days, it was white to old rose, and in 4 weeks patches of slate purple sometimes developed. There were colourless masses of plectenchyma between the medium and the glass. Cultures were faintly or strongly aromatic.

Measurements of Conidia.

Oat agar, culture 2 weeks old, conidia from sporodochia.		
5-septate............	1·5 per cent........	50–52·5 × 3·8–5.
4-septate............	5 ,, ...	42·5–52·5 × 4–4·5.
3-septate............	89 ,, ...	20–47·5 × 3·7–4·5.
2-septate............	1·5 ,, ...	20–22·5 × 3·7.
1-septate............	0·5 ,, ...	12–18 × 2·5–3·5.
0-septate............	2·5 ,, ...	5–7·5 × 2·3.
Hard potato agar, culture 4 weeks old, conidia from pionnotes.		
3-septate............	99 per cent..........	22–37·5 × 4–4·7.
2-septate............	1 ,,	
Bean pod, culture 4 weeks old, conidia from sporodochia.		
3-septate............	98 per cent..........	22·5–37·5 × 3–5.
2-septate............		
1-septate............		
Bean pod, culture 2 weeks old, conidia from sporodochia.		
5-septate............	1·5 per cent........	42·5–47·5 × 4-4·5.
4-septate............	5·5 ,, ...	37·5–47·5 × 3·7–4·5.
3-septate............	39·5 ,, ...	30–45 × 3·7–4·5.
2-septate............	0·5 ,,	
1-septate............	1 ,,	
0-septate............	52 ,,	
Melilotus stem, culture 2 weeks old, conidia from sporodochia.		
4-septate............	0·5 per cent........	33–45 × 4–4·5.
3-septate............	95·5 ,, ...	22·5–45 × 3–4·5.
2-septare............	0·5 ,,	
0-septate............	3·5 ,,	

Fusarium oxysporum Schl. *f.* 1 Wr.

Wollenweber, Fusarium-Monographie, 418, 1931; Fus. aut. del. 379, 391. Wollenweber and Reinking, Die Fusarien, 119, 1935.

Syn. *Fusarium euoxysporum* Wr.; *F. oxysporum* aut. pr. p.

? *F. redolens* Wr. v. *angustius* Lindfors.

This is a form of *F. oxysporum* which is a specfic parasite of potato (*Solanum tuberosum*), causing wilt.

Conidia 0-septate..............	5–15 × 2–4..........	Mostly 7–10 × 2·1–3.
1-septate..............	10–26 × 2–4·5.......	Mostly 12–17 × 2·5–3·4.
3-septate..............	19–46 × 2·5–5.......	Mostly 23–40 × 3–4·6.
5-septate..............	30–60 × 3–6..........	Mostly 38–49 × 3·8–5.

Macroconidia in sporodochia mostly 3-septate, seldom 4–5-septate. Microconidia produce freely in the aerial mycelium. Stroma effuse, smooth, or sclerotially erumpent, pale to green or blue-black. Cultures on rice usually aromatic. Chlamydospores typical.
Hab. *Solanum tuberosum* L., from stems of wilting plants, which showed more or less typical blackening of vascular tissues and of the vascular ring in the tubers; Northern Transvaal, April 1932; Schietfontein, De Wildt, Transvaal (Wager); Louis Trichardt, N. Transvaal (Wager); Mbabane, Swaziland, 1931 (Wager): Moorddrift and Planknek, Potgietersrust, Transvaal, March 1932.

Also reported by du Plessis (13) from stem of wilting plant, Darling, Cape.

Fusarium oxysporum f. 1 is a cause of potato wilt in North America, Asia and Africa, comparatively rarely in Europe. Cultural characters and measurements of conidia closely resemble those of *F. oxysporum*.

Fusarium oxysporum Schl. var. **nicotianae** Fohns.

Johnson, Jour. Agric. Res. 20: 515–535, 1921. Wollenweber and Reinking, Die Fusarien, 120, 1925. Wollenweber, Fus. aut. del. 625.

Syn. *Fusarium nicotianae* Oud.; *F. tabacivorum* Del.
F. oxysporum Schl. *f.* 5 Wr.

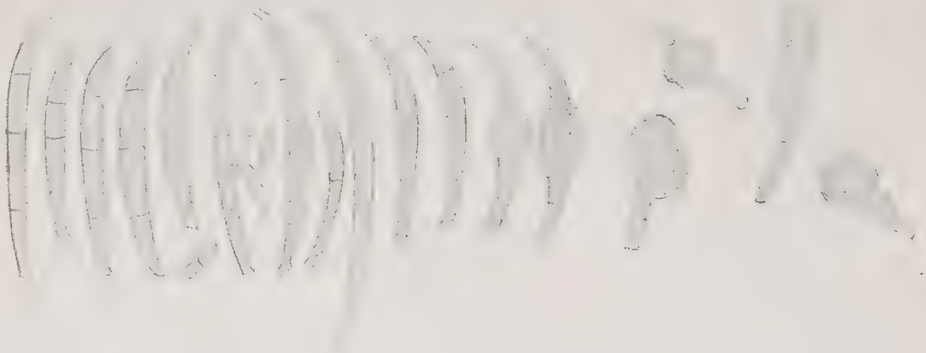

Fig. 32.

Fusarium oxysporum Schl. v. *nicotianae* Johns.; (*a*) conidia from sporodochia of 8 weeks old culture on Melilotus stem, (*b*) chlamydospores from the same culture.

This form has rather longer conidia than *F. oxysporum f.* 1 and *f.* 2, and is a specific parasite of the tobacco plant. Microconidia numerous, 1-celled or occasionally 1–2-septate. Macroconidia in sporodochia and sometimes in pionnotes, 3-septate, less frequently 4–5-septate; 3-septate $35 \times 4{\cdot}2$; 5-septate $44{\cdot}3 \times 4$. Chlamydospores 6–10·2 (av. 8·2). Sclerotia blue-black, comparatively numerous. Fungus not aromatic.
Hab. *Nicotiana tabacum* L., from plants affected at the collar, and showing discoloration of the vascular tissues for some distance up the stem, Buffelspoort, Rustenburg Dist. (Moore).

This variety is a cause of tobacco wilt in North America and probably also in Asia, Africa and Europe.

Growth on Standard Media.

Oat agar: Aerial mycelium moderate, cottony to tomentose, white to pale lilac. Growth in substratum pale lilac to vivid purple, colour fading with age. Sclerotial bodies developed later, especially near the base of the slant. After 4 weeks, small sporodochia appeared; they were light ochraceous salmon.

Hard potato agar: Aerial mycelium moderate, cottony; growth on substratum colourless.

Standard synthetic agar plus starch : Aerial mycelium moderate, cottony. Growth on substratum colourless at first ; in older cultures stroma and agar tinged dark purple drab. Sclerotial bodies present.

Potato agar plus 5 per cent. dextrose : Aerial mycelium fairly abundant, tomentose, white to pale lilac. Growth on substratum at first pale lilac, with a line of naphthalene violet at the base of the slant ; later naphthalene violet, and the agar tinged with the colour of the stroma. A few light ochraceous salmon conidial masses developed on tufts of mycelium.

Potato plug : Plug covered with a dense mycelial growth, which was cottony, with a tendency to become wrinkled and felt-like, white tinged with pale lilac in places. There were patches of blue-black on the substratum, and in older cultures, numerous, large, erumpent sclerotial masses developed ; these were at first pale, then blue-black.

Melilotus stem : Mycelium thin, white or tinged purplish lilac. After some weeks, a few irregular sclerotial outgrowths developed from the stroma, and there were a few small sporodochia, which were light ochraceous salmon to light pinkish cinnamon.

Bean pod : Pod became covered with a scant to moderate mycelial growth, which was white, cottony to sericeo-tomentose, and sometimes mealy-looking, owing to the presence of numerous conidia.

Rice : Growth white to purplish lilac at first. In older cultures the superficial mycelium was white and growth on substratum dull bluish violet to dark hyssop violet and vinaceous lilac. The culture was not aromatic.

Measurements of Conidia.

Melilotus stem, culture 8 weeks old, conidia from sporodochia.

5-septate............	Few.................	$35–45 \times 4–5$.
4-septate............	2 per cent..........	$32·5–42·5 \times 3·7–5$.
3-septate............	91 ,, ...	$22·5–42·5 \times 3–4·5$.
1-septate............	2 ,,	
0-septate............	5 ,,	

Potato agar plus 5 per cent. dextrose, culture 8 weeks old, conidia from sporodochia.

5-septate............	2·5 per cent........	$40–48 \times 4–5$.
4-septate............	30 ,, ...	$37·5–46·5 \times 4–5$.
3-septate............	61 ,, ...	$30–42·5 \times 3·7–5$.
1-septate............	1 ,,	
0-septate............	5·5 ,,	

Fusarium oxysporum Schl. **f. 7** Wr.

Wollenweber and Reinking, Die Fusarien, 120–121, 1935. Wollenweber, Fus. aut. del. 1176.
Syn. *Fusarium cepae* Hanz.
F. cepae Hanz. emend. Link et Bailey.

This form is a parasite of onion (*Allium*) ; it does not attack potato, nor is *f*. 1 parasitic on onion ; 3-septate conidia are $33–36 \times 3·8–4·5$, and 5-septate $44 \times 3·9$; 6-septate conidia rare, $52 \times 3·3$.

Hab. *Allium cepa* L., from young plants dying off in seed beds, Pyramids, Pretoria Dist., March 1932 (Mogg) M.H. 28393 ; from bulbs and leaf bases, Nelspruit (Wager) M.H. 28433.

Also reported by du Plessis (12), as occurring in the winter rainfall area, and causing pink root and bulb of onions, Caledon, Ceres, the Peninsula, Franschhoek, Riversdale, Stellenbosch and Tulbagh.

Growth on Standard Media.

In culture, this form does not differ materially from *F. oxysporum*. Sporodochia salmon-buff to salmon colour. Sclerotial masses on potato small, numerous, dark bluish

grey green to dark delft blue. Chlamydospores numerous, in mycelium and conidia, mostly 1–2-celled, terminal and intercalary; 1-celled 5–6·5 μ diameter. Rice cultures faintly aromatic.

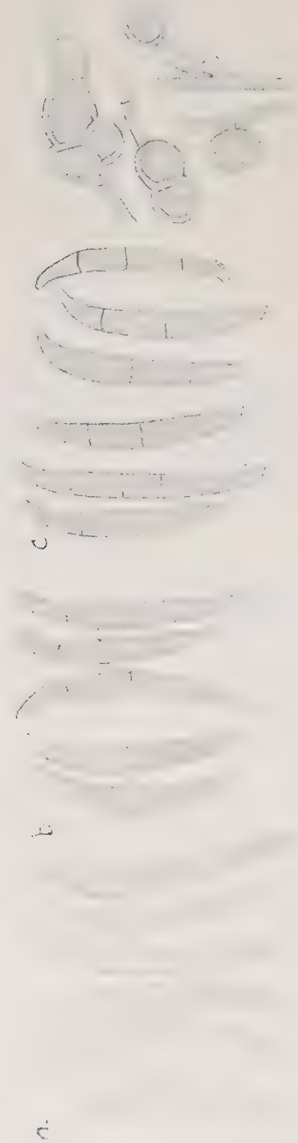

Fig. 33.

Fusarium oxysporum Schl. *f.*7 Wr.; conidia from sporodochia of 4 weeks old culture on (*a*) oat agar, (*b*) Melilotus stem, (*c*) potato plug, (*d*) chlamydospores from culture on oat agar, 4 weeks old.

Measurements of Conidia.

Oat agar, culture 4 weeks old, conidia from sporodochia.

5-septate............	0·5 per cent........	37·5–42·5 × 3·7–5.
4-septate............	3·5 ,, ...	31–50 × 3–5.
3-septate............	41 ,, ...	22·5–46·5 × 3–4.
1-septate............	3·5 ,, ...	10–18 × 2·5–3·25.
0-septate............	51·5 ,, ...	7·6–10·5 × 1·8–3.

Potato, culture 4 weeks old, conidia from sporodochia.

5-septate............	0·5 per cent........	37·5–55 × 3–4·7.
4-septate............	4 ,, ...	32·5–45 × 3–4·4.
3-septate............	91 ,, ...	20–42·5 × 3–4·5.
1-septate............	1 ,, ...	10–15 × 2·5–4.
0-septate............	3·5 ,, ...	8–10 × 2–3.

Melilotus stem, culture 4 weeks old, conidia from sporodochia.

5-septate............	0·5 per cent........	40–44 × 3·7–5.
4-septate............	5 ,, ...	35–47·5 × 3·7–4·7.
3-septate............	94·5 ,, ...	22·5–45 × 3–4·7.

Fusarium oxysporum Schl. **f. 8** Snyder.

Snyder and Walker, Fusarium near-wilt of pea, Zentralbl. f. Bakt. 11 Abt. 91: 355–378, 1935. Wollenweber and Reinking, Die Fusarien, 121, 1935.

Syn. *Fusarium vasinfectum* Atk. v. *pisi* van Hall.

Fig. 34.

Fusarium oxysporum Schl. *f.*8 Snyder; Conidia from pionnotes of 2 weeks old culture on (*a*) bean pod, *b*) hard potato agar, and (*c*) oat agar.

Conidia in sporodochia and pionnotes, 3-septate, less frequently 4–5-septate, exceptionally 6–7-septate; smaller 1–2-septate conidia are also found, and numerous microconidia scattered in the mycelium.

3-septate............	25–59 × 2·8–5.......	Mostly 32–38 × 3·8–4·3.
5-septate............	35–71 × 3·4–5.......	Mostly 35–50 × 4–4·3.

Sclerotia and sclerotial bodies occur, they are 0·5–2–5 mm. diameter, blue, green or pale. Chlamydospores 4–14 μ diameter.

Hab. *Pisum sativum* L., ? from stems of wilting pea plants, Tygerpoort, Pretoria Dist., (Fourie).

F. oxysporum f. 8 is parasitic on peas (*Pisum*), causing the disease known as "St. John's wilt" in Europe, and "near wilt" in the United States. An organism apparently identical with this form was obtained in pure culture from a number of wilting pea plants from Tygerpoort, but the identity of the South African fungus with *F. oxysporum f.* 8 needs confirmation by inoculation.

Growth on Standard Media.

In culture *f.* 8 resembles *F. oxysporum*, and is just as variable in the pigmentation of the stroma, and in the presence or absence of dark blue or pale sclerotia. The presence of an aromatic odour in rice cultures is also variable.

Measurements of Conidia.

Oat agar, culture 2 weeks old, conidia from pionnotes.

5-septate............	2 per cent........	42·5–50 × 3·7–4·7.
4-septate............	11 ,, ...	37·5–47·5 × 4·4.
3-septate............	34 ,, ...	27·5–50 × 3·7–4·7.
1-septate............	0·5 ,,	
0-septate............	52·5 ,,	

Hard potato agar, culture 2 weeks old, conidia from pionnotes.

9-septate............	Only one seen........	72·5 × 3·75.
5-septate............	8 per cent........	47·5–57·5 × 3·75–5.
4-septate............	12·5 ,, ...	40–52·5 × 3·7–4·4.
3-septate............	66·5 ,, ...	25–60 × 3·5–4·5.
2-septate............	3 per cent.	
1-septate............	6 ,,	
0-septate............	4 ,,	

Bean pod, culture 2 weeks old, conidia from pionnotes.

5-septate............	Rare.................	52·5 × 4·4.
4-septate............	2 per cent..........	36–50 × 4–4·7.
3-septate............	86 ,, ...	27·5–45 × 3·5–4·5.
0-septate............	12 ,,	

Fusarium oxysporum Schl. var. **aurantiacum** (Lk.) Wr.

Wollenweber, Fusarium-Monographie, 420–422, 1931; Fus. aut. del. 381–386, 627, 1013–1016, 1185–1187. Wollenweber and Reinking, Die Fusarien, 121–122, 1935.

Syn. *Fusarium aurantiacum* (Lk.) Sacc; *F. calcareum* (Thuem.) Sacc.
F. elongatum Pratt; *F. Peckii* Sacc. pr. p.
F. Saccardoanum Syd.; *F. sclerodermatis* Peck.
F. sclerotioides Sherb.

This variety has somewhat larger 3–5-septate conidia than the type, and a larger proportion of 4–5-septate conidia. Sclerotial bodies are sometimes 1–3 mm. diam., and sometimes more extensive, 4–6–12 mm. On rice the stroma is a deeper purple violet than in cultures of *F. oxysporum*, and is sometimes almost chestnut brown. Rice cultures are not aromatic.

0-septate............	5·5–9·5 × 2·2–2·7...	Average 7·2 × 2·6.
1-septate............	12–17 × 2·5–3·8.....	Average 14 × 3·1.
3-septate............	23–48 × 3–5·5.......	Mostly 30–42 × 3·5–4·8.
5-septate............	33–70 × 3–5·5.......	Mostly 38–57 × 3·8–4·7.
7-septate............	36–75 × 3·3–4·5.....	Mostly 41–65 × 3·7–4·6.

Chlamydospores more or less common, spherical to oval, 8·5 × 8 (5–12 diam.), 2-celled 11–14 × 7–9 (average 13·5 × 8).

Hab. *Antirrhinum majus* L., from stems of wilting plants, Johannesburg (Wager).

Arachis hypogaea L., from pods showing a pink discolouration of the shell, University Farm, Pretoria (F. du Toit).

Brassica oleracea L., from stems of wilting seedlings, Witpoortjie, Krugersdorp Dist.; also on half grown plants showing symptoms similar to those of "yellows."

Cupressus lusitanica Mill., from stems of dying seedlings, Xumeni Forest, Donnybrook, Natal, M.H. 28388.

Phaseolus sp. from stems of wilted plants, Nelspruit, E. Transvaal (Wager), and from Swaziland.

Pinus longifolia Roxb., from dying seedlings, N. Transvaal (Bottomley).

Pinus palustris Mill. and *P. taeda*, from stems of dying seedlings, Dukduku plantation, St. Lucia Bay, Zululand.

This fungus occurs in Europe, Asia and America. It is a saprophyte on decaying parts of plants, and is parasitic on conifer and cyclamen seedlings.

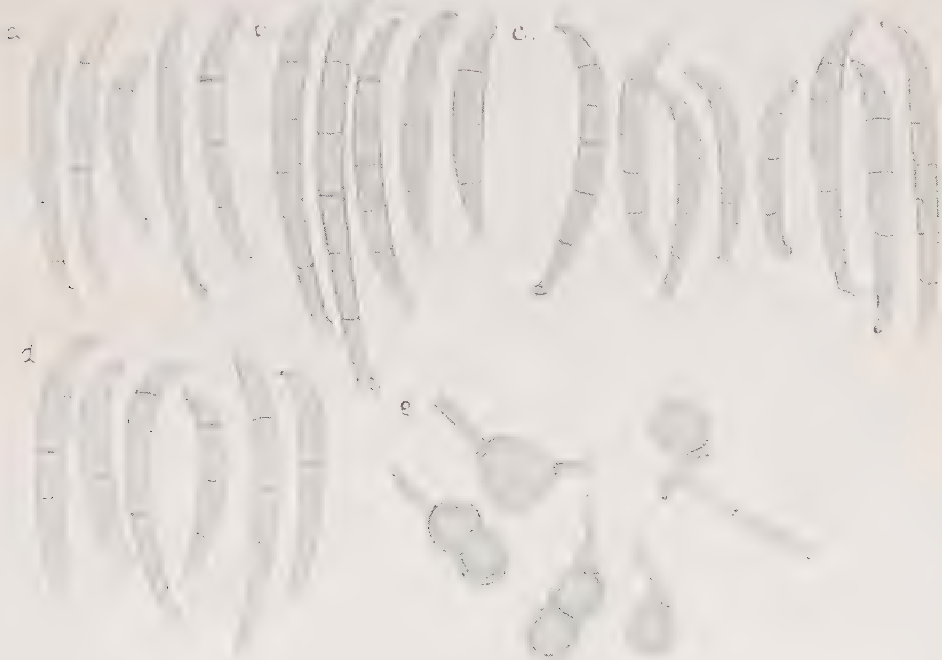

Fig. 35.

Fusarium oxysporum Schl. v. *aurantiacum* (Lk.) Wr.; conidia from (*a*) sporodochia of culture on Melilotus stem, (*b*) pionnotes on hard potato agar, (*c*) pionnotes on standard synthetic agar plus starch, (*d*) sporocochia of culture on oat agar; all cultures 2 weeks old; (*e*) chlamydospores from a 4 weeks old culture on hard potato agar.

Growth on Standard Media.

Oat agar: Aerial mycelium sparse or moderate in amount, cottony or matted, white to pale flesh colour, or tinged pinkish vinaceous near the substratum. Growth on substratum purplish vinaceous. Large, irregular, wart-like sclerotial masses developed, especially near the base of the slant; they were up to 5 mm. diam., and were at first colourless, then tinged with green, and finally blue-black. Sporodochia developed in groups, and were often coalescent, forming a continuous pionnotal layer; conidia in mass were light pinkish cinnamon to ochraceous salmon.

Hard potato agar: Aerial mycelium sparse, white, cottony; growth on substratum colourless. Numerous minute sporodochia developed, which soon ran together and formed a continuous pionnotes. A few minute sclerotia appeared at the base of the slant.

Standard synthetic agar plus starch: Aerial mycelium very sparse. Growth on substratum deep vinaceous lavender, and after 8 weeks, the agar was stained light russet vinaceous. Pionnotes developed freely, buff pink.

Potato agar plus 5 *per cent. dextrose :* Aerial mycelium fairly plentiful, cottony or matted, white to pale vinaceous lilac. Growth on substratum dull Indian purple to dark slate purple. After 4 weeks, the agar was stained brown to almost black. Numerous deep delft blue sclerotia were present after 4 weeks.

Potato plug : Plug covered with a dense mycelial growth, which was white to pale lilac, cottony or becoming felt-like and wrinkled. Sclerotial masses at first small and pale, becoming bluish-green and finally blue-black and developing into irregular, raised, rough masses, up to 5 mm. or occasionally 10 mm. in diameter. A few sporodochia developed ; they were pale pinkish cinnamon.

Melilotus stem : Aerial mycelium rather thin, white to shell pink. Stems became covered with numerous sclerotial masses, which were 1–3 mm. diam., at first pale, then greenish blue, and finally blue-black. A few sporodochia developed.

Bean pod : Mycelium rather thin, or moderate in amount. Pinkish cinnamon sporodochia developed in 14 days ; they were small, scattered or in groups. A few minute, blue-black sclerotia were present.

Rice : Growth white to alizarine pink, venetian pink and old rose, becoming acajou red and pompeian red in places. Masses of plectenchyma developed between the medium and the glass. Not aromatic.

Measurements of Conidia.

Hard potato agar, culture 14 days old, conidia from pionnotes.

6–7-septate............	2 per cent........	35–55 × 4–5.
5-septate............	8 ,, ...	36–55 × 3·7–4·7.
4-septate............	23 ,, ...	35–55 × 3–4·5.
3-septate............	66·5 ,, ...	37·5–45 × 3·7–5.
2-septate............	0·5 ,, ...	22·5–40 × 3·7–5.
0-septate............	1 ,,	

Bean pod, culture 14 days old, conidia from sporodochia.

5-septate............	3·5 per cent........	35–54 × 3·5–5.
4-septate............	13 ,, ...	32·5–50 × 3·5–5.
3-septate............	80 ,, ...	27–45 × 3·3–5.
2-septate............	1 ,, ...	20–30 × 3·7–4.
1-septate............	1·5 ,,	
0-septate............	1 ,,	

Oat agar, culture 2 weeks old, conidia from sporodochia.

5-septate............	1 per cent..........	42·5–60 × 3·7–4.
4-septate............	17 ,, ...	37·5–57·5 × 3·3–5.
3-septate............	82 ,, ...	27·5–50 × 3·3–4·5.

Standard synthetic agar plus starch, culture 2 weeks old, conidia from sporodochia

5-septate............	10 per cent........	45–57·5 × 3·7–5.
4-septate............	37 ,, ...	42·5–55 × 3·5–5.
3-septate............	52 ,, ...	30–50 × 3·5–4·5.
1-septate............	0·5 ,,	
0-septate............	0·5 ,,	

Fusarium oxysporum Schl. var. **gladioli** Massey.

Massey, Fusarium rot of Gladiolus corms, Phytopathology 16 ; 509–523, 1926. Wollenweber and Reinking, Die Fusarien, 122–123, 1935. Wollenweber, Fus. aut. del. 1183, 1184.

The conidia of this variety are broader than those of the type, and in this respect approach in form those of var. *aurantiacum*. Conidia, measure :—

0-septate............	6 × 2·7.	
1-septate............	13 × 3·2.	
3-septate............	25–41 × 3·5–4·8.....	Average 33·4 × 4·3.
5-septate............	42–46 × 4·3–4·6.....	Average 44 × 4·5.
7-septate............	40–44 × 4·8.........	Average 42 × 4·8.

The macroconidia are produced in salmon-orange sporodochia, which are up to 2 mm. diameter; they are 3–4-septate, less frequently 5-septate, or exceptionally up to 7-septate. Chlamydospores spherical, smooth, terminal or intercalary, mostly 1-celled; chlamydospores in or on the conidia are smaller (6–14 × 5–10) than those arising in the mycelium (7–17 × 7–10). The aerial mycelium is floccose, well developed, white, and up to 5 mm. high. Dark blue sclerotia are present and numerous.

Hab. *Gladiolus* sp., from corms and leaf bases, Princess Park, Pretoria.

The younger leaves turned brown, and plants failed to flower; corms were still firm but were discoloured brown, especially near the base. The identity of the organism with *F. oxysporum* v. *gladioli* needs confirmation by inoculation into healthy plants. Variety *gladioli* is the cause of decay of *Gladiolus* corms in North America and Australia.

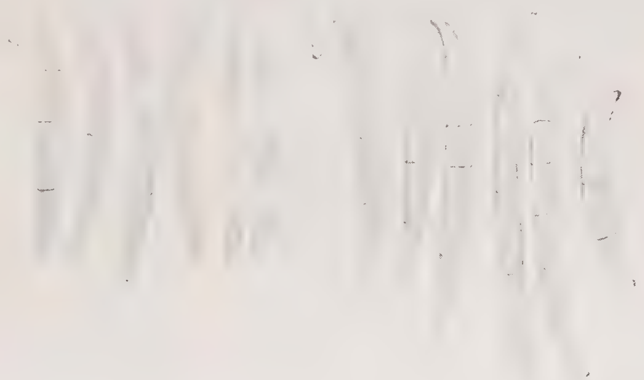

Fig. 36.

Fusarium oxysporum Schl. v. *gladioli* Mass.; conidia from pionnotes of 2 weeks old cultures on (*a*) oat agar, (*b*) hard potato agar.

Growth on Standard Media.

In culture, the *Gladiolus* organism did not differ materially from *F. oxysporum*.

Measurements of Conidia.

Melilotus stem, culture 4 week old, conidia from sporodochia.

3-septate	51 per cent	20–37·5 × 3·7–4·7.
2-septate	8 ,,	15–26·5 × 3–3·5.
1-septate	2·5 ,,	12·5–18 × 3–3·5.
0-septate	33 ,,	4–11 × 2·5–4.

Standard synthetic agar plus starch, culture 12 weeks old, conidia from sporodochia.

6-septate	0·5 per cent	43 × 4·7.
5-septate	4·5 ,,	40–45 × 4–4·7.
4-septate	17 ,,	40–42 × 4–4·7.
3-septate	48 ,,	28–42 × 3·5–4·7.
2-septate	4 ,,	15–25 × 3·3–4.
1-septate	2 ,,	15–20 × 3–3·5.
0-septate	24 ,,	6–10 × 2·5–3.

Fusarium dianthi Prill. et Del.

Delacroix, La maladie des oeillets d'Antibes, Ann. Inst. Agron. Nancy, 16: 1901. Wollenweber and Reinking, Die Fusarien, 123–124, 1935. Wollenweber, Fus. aut. del. 1188–1189.

The conidia occur in light orange, sporodochial and pionnotal masses; they are fusiform-falcate, pedicellate, often abruptly bent at the constricted apex, and a little thicker

in the upper third than in the middle, definitely dorsiventral, mostly 3– or 3–5-septate, exceptionally 1–2- or 6–8-septate. Micorconidia numerous, 1-celled, or with 1–2-septations, scattered in the floccose aerial mycelium, which is white to pink.

0-septate............	5-15 × 1·5 4·5......	Mostly 7–11 × 2·3·6.
1-septate............	10–30 × 2–4.........	Mostly 15–21 × 2·4–3·3.
3-septate............	16–63 × 2·5–4.......	Mostly 23–52 × 3·1–4·5.
5-septate............	30–80 × 3–5·5.......	Mostly 37–69 × 3·6–5.
7–9-septate............	70–100 × 3·8–4.	

The more compact 3-septate conidia average 31 × 4·3, the more slender 37 × 3·7. Chlamydospores round, smooth or rough, 6–12 (av. 8·1), 2-celled ellipsoid-oval, 13–16 × 5–13. The fungus is not aromatic.

Hab. *Dianthus caryophyllus* L., from stems of wilting plants, Bethlehem, O.F.S.; Elim and Politsi, N. Transvaal; Durban, Natal; Golden Valley, Cape.

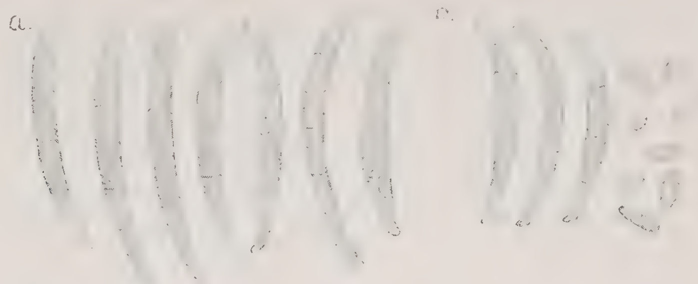

Fig. 37.

Fusarium dianthi Prill. et Del.; conidia from sporodochia of 8 weeks old cultures on (*a*) potato agar plus 5 per cent. dextrose, (*b*) oat agar.

Growth on Standard Media.

In culture, the strains studied closely resembled *F. oxysporum* var. *aurantiacum*.

Measurements of Conidia.

Oat agar, culture 8 weeks old, conidia from sporodochia.

6-septate............	0·5 per cent........	38–57 × 4·5–5.
5-septate............	2 ,, ...	40–60 × 4–5.
4-septate............	4 ,, ...	35–52 × 3–4·5.
3-septate............	89 ,, ...	23–45 × 3–4·5.
1-septate............	0·5 ,, ...	16–20 × 2·5–3.
0-septate............	4 ,, ...	6–12 × 2–3·4.

Potato agar plus 5 per cent. dextrose, culture 8 weeks old, conidia from sporodochia.

3-septate................................	25–40 × 3–4·5.
2-septate................................	20–30 × 3·5–4.
1-septate................................	15–24 × 3–3·75.

Fusarium vasinfectum Atk.

Atkinson, Some diseases of cotton, Agric. Exp. Sta. Alabama, Bull. 41; 19, 1892. Wollenweber, Fusarium-Monographie, 423, 1931; Fus. aut. del. 376. Wollenweber and Reinking, Die Fusarien, 124, 1935.

Syn. *Fusarium malvacearum* Taub.

Differs from *F. oxysporum* in the somewhat narrower conidia, the free development of pionnotes, the comparatively small, green to blue sclerotial plectenchyma (0·1–2 mm. diam.), and the purple-red plectenchymatous stromata. Microconidia 1-celled, or with one

or two septations, scattered. Macroconidia in sporodochia and pionnotes, isabellinous to light salmon orange in mass; fusiform-falcate, somewhat constricted, tapering or rostrate at both ends, base pedicellate or papillate.

0-septate............	4–12 × 2–3..........	Mostly 6·7–9·5 × 2·3–2·8.
1-septate............	8–25 × 2–4..........	Mostly 13–20 × 2·8–3·3.
3-septate............	23-48 × 3–4·5.......	Mostly 27–40 × 3·3–4.
5-septate............	30–50 × 3–5 rare)....	Mostly 32–48 × 3·5–4.

Chlamydospores terminal and intercalary, 1-celled, 7–13 (av. 8·8), or 2-celled 12·6 × 7. The fungus has a strong, lilac-like odour on rice media.

Hab. *Hibiscus sabdariffa* L., from stems of wilting plant, Schagen, E. Transvaal (Wager).

This fungus is the cause of a vascular wilt of cotton, *Gossypium herbaceum* and *G. barbadense*, and probably also of *Hibiscus esculentus*. It occurs most frequently in North America. A vascular wilt of cotton caused by a *Fusarium* sp., has been observed in South Africa, and is probably due to this fungus, but it was not found during the time this work was in progress, and has not been studied in culture, nor have any tests of its pathogenicity been made.

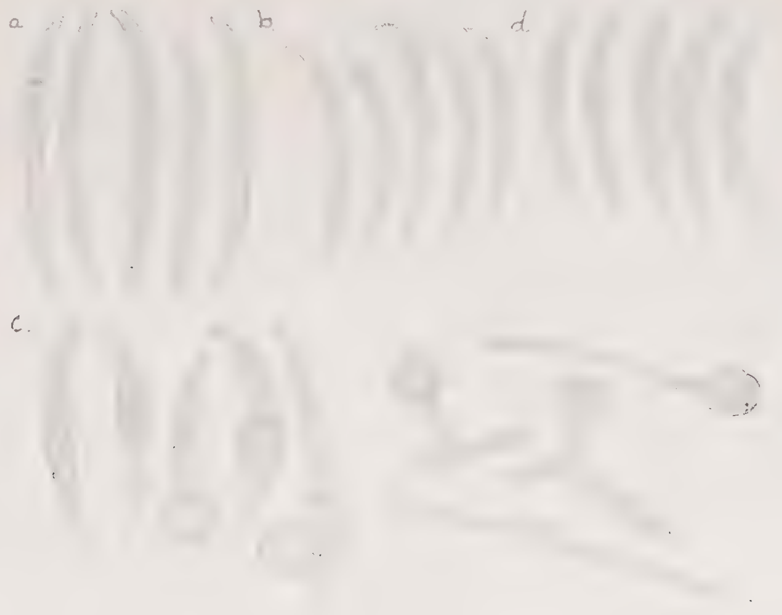

Fig. 38.

Fusarium vasinfectum Atk.; conidia from (*a*) pionnotes of culture on plain agar, 7 days old; from sporodochia of 4 weeks old cultures on (*b*) oat agar, (*c*) standard synthetic agar plus starch, and (*d*) pionnotes of 8 weeks old culture on hard potato agar, (*e*) chlamydospores from mycelium on hard potato agar, culture 4 weeks old.

Growth on Standard Media.

Oat agar: Aerial mycelium rather sparse, fine, white, cottony. Growth on substratum vinaceous pink to light vinaceous purple; numerous minute sclerotia developed, especially near the base of the slant, up to 2 mm., diam., at first pale, becoming blue-black. Groups of sporodochia were light buff to light pinkish cinnamon. In some tubes there was a patch of dusky dull green plectenchyma at the base of the slant.

Hard potato agar: Mycelium short, white, sparse. Growth on substratum colourless. A few small sclerotia formed along the edge of the medium, especially where it was drying. Pionnotes developed along the needle track

Standard synthetic agar plus starch : There was a very little aerial mycelium at the base of the slant, elsewhere none. Growth on substratum vinaceous pink to deep vinaceous lavender. Pionnotes and groups of sporodochia light buff to light pinkish cinnamon.

Potato agar plus 5 per cent. dextrose : Aerial mycelium moderate in amount, white to flesh pink and deep purplish vinaceous, sometimes becoming acajou red. Growth on substratum dull Indian purple to Hay's maroon, sometimes with patches of deep delft blue or Russian green. The medium was, in some tubes, stained sorghum brown to vinaceous brown.

Potato plug : Plugs covered with a moderate amount of white, cottony mycelium, which sometimes became wrinkled and felt-like. Sclerotia numerous, minute, 1 mm. diam., or up to 2·5 mm., at first colourless, becoming greenish blue to blue-black. In some tubes there were patches of dark bluish grey green on the substratum. A few small sporodochia developed.

Melilotus stem : Aerial mycelium scant to moderate, white, cottony or tufted. Sclerotia numerous, small, deep delft blue. Sporodochia fairly numerous, light ochraceous salmon, 2–3 mm. diam.

Bean pod : Pods covered with a white mycelium, which was thin and cottony or felt-like and wrinkled. Fairly numerous small sclerotia and pale pinkish cinnamon sporodochia developed.

Rice : Growth at first flesh pink to alizarine pink, or purplish lilac to pruplish vinaceous ; later it was jasper pink to old rose. Groups of colourless plectenchyma developed between the medium and the glass. Culture aromatic, with an odour resembling lilac.

Measurements of Conidia.

Oat agar, culture 4 weeks old, conidia from sporodochia.		
4–5-septate	1 per cent	35–40 × 4.
3-septate	87·5 ,,	30–42·5 × 3·7–4·5.
2-septate	4·5 ,,	25–35 × 3–4·5.
1-septate	1·5 ,,	20–24 × 3–3·7.
0-septate	5·5 ,,	7–10 × 2–3.
Hard potato agar, culture 8 weeks old, conidia from pionnotes.		
4–5-septate	Few	40–47·5 × 3·7–5.
3-septate	22 per cent	27·5–40 × 3–4·5.
2-septate	2 ,,	25 × 3.
1-septate	7 ,,	15–25 × 3·7–4.
0-septate	69 ,,	
Chlamydospores developed in many conidia.		
Melilotus stem, culture 8 weeks old, conidia from sporodochia.		
3-septate	45 per cent	18·7–40 × 3–4·5.
2-septate	1 ,,	17·5–30 × 2·75–3·75.
1-septate	4 ,,	12·5–20 × 2·5–3·75.
0-septate	50 ,,	5–9·5 × 2–3.
Standard synthetic agar plus starch, culture 4 weeks old, conidia from sporodochia		
3-septate	80 per cent	30–42·5 × 3·7–4·5.
2-septate	15 ,,	22·5–35 × 3·7–4·5.
1-septate	4 ,,	17·5–30 × 3·7–4·5.
0-septate	1 ,,	

Fusarium vasinfectum Atk. **f. 2** Wr. et Rkg.

Wollenweber and Reinking, Die Fusarien, 125, 1935. Wollenweber, Fus. aut. del. 1191.

This form was established by Wollenweber and Reinking to include provisionally a number of fungus strains, which are morphologically similar to *F. vasinfectum*, but which have not proved capable of producing cotton wilt. The typical 3-septate conidia correspond

with those of the type, and are 24–50 × 3·5–4·5. On rice media the stroma is purple red, and cultures on rice may or may not be aromatic. Chlamydospores terminal and intercalary.

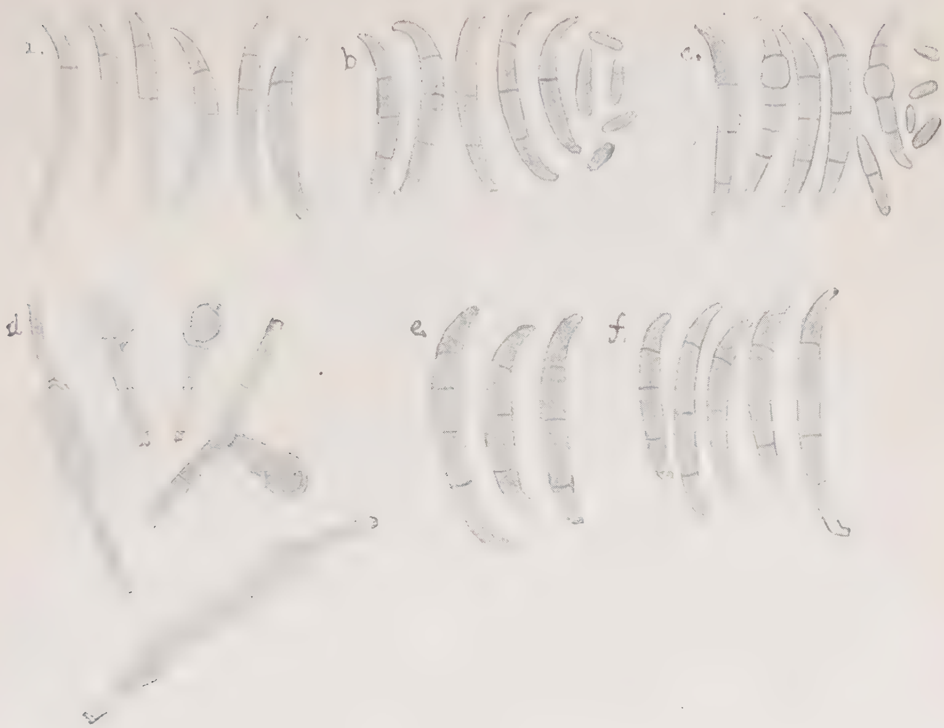

Fig. 39.

Fusarium vasinfectum Atk. *f.*2 Wr.; conidia from (*a*) sporodochia of 4 weeks old culture on Melilotus stem; pionnotes on sclerotia of 12 weeks old culture on (*b*) rice and (*c*) potato agar plus 5 per cent. dextrose, (*d*) chlamydospores from 12 weeks old rice culture; conidia from pionnotes of 9 weeks old cultures on (*e*) hard potato agar, and (*f*) oat agar.

Hab. *Citrus sinensis* Osbeck, from fruit; from brown lesions at the stem end, varying from small discolourations under the button to extensive rotted areas, after fruit had been 18 weeks in storage; in Valencia oranges from Sunday's River, Cape (2 isolations), and White River, Transvaal (5 isolations).

On trunk; on strips of bark, apparently killed by lightning, Grahamstown, Cape, Nov. 1931 (Jolly) M.H. 28420; on bark above union, (roots of trees water-logged), Letaba Estates, N. Transvaal.

On roots of old seedling orange tree, Villiersdorp, Cape.

Citrus limonia Osbeck, from roots showing dry root rot lesions, Bonnievale, Cape (van der Hoek) M.H. 28402; Prudential Estates, E. Transvaal, 1930, .MH. 28440.

Matthiola incana R. Br., from stems of dying plants, Uitenhage, Cape (Wilson).

Messembrianthemum sp., from stems of succulent plants which were rotting, Pretoria (Wager).

Sesamum orientale L., from stems of wilting plants, Pretoria University Farm, April 1932 (F. du Toit).

Fusarium vasinfectum Atk. var. **lutulatum** (Sherb.) Wr.

Wollenweber, Fusarium-Monographie, 424, 1931; Fus. aut. del. 380, 1019, 1192. Wollenweber and Reinking, Die Fusarien, 125, 1935.

Syn. *Fusarium lutulatum* Sherb.

Fig. 40.

Fusarium vasinfectum Atk. v. *lutulatum* (Sherb.) Wr.; conidia from sporodochia and pionnotes of 2 weeks old cultures on (*a*) oat agar, (*b*) hard potato agar, (*c*) standard synthetic agar plus starch, (*d*) Melilotus stem; chlamydospores from (*e*) 4 weeks old culture on hard potato agar and (*f*) plain agar plates, 7 days old.

This variety has somewhat longer conidia than the type, and small, blue-black sclerotial bodies (up to 0·5 mm. diam.) may be numerous or absent. The conidia are mostly 3-septate, seldom 4- or 5-septate. Numerous 1–2-celled microconidia occur in the aerial mycelium.

3-septate.................................. Mostly 28–42 × 3·2–4·5.
5-septate.................................. Mostly 37–47 × 3·5–4·5.
6–7-septate.................................. Exceptional, 50–66 × 3·5–5.

Chlamydospores terminal and intercalary, 1-celled, 6–8 × 5–7; 2-celled, 8–12 × 4–7. The fungus is aromatic on rice media.

Hab. *Centaurea moschata* L., from stems of wilted plants, Pretoria (Wager) M.H. 28405.

Lathyrus odoratus L., from stems of seedlings which were wilting, and also from stems of plants dying when reaching the flowering stage (sometimes associated with *Pythium* sp.), Brooklyn, Pretoria (Doidge).

Pisum sativum L., from wilting seedlings and older plants, E. Transvaal (Wager).

Growth on Standard Media.

Oat agar : Aerial mycelium sparse, white, cottony. Growth on substratum pale vinaceous pink to pale flesh colour. A number of minute, scattered sclerotia, 0·1–0·5 mm. diam., which became deep delft blue, developed in some tubes. Numerous small sporodochia developed on the lower half of the slant: these were light vinaceous cinnamon to light ochraceous salmon, and they remained discrete, or coalesced to form a continuous pionnotal layer.

Hard potato agar : A little, short, white, cottony mycelium developed over the face of the slant. Small sporodochia and pionnotes formed freely; they were pale cinnamon pink to light vinaceous cinnamon.

Standard synthetic agar plus starch : Aerial mycelium scant. Growth on substratum colourless, or with a purplish tinge in places. Conidial masses vinaceous cinnamon to flesh colour, developing as on oat agar. Agar sometimes tinged pink. A few minute sclerotia occasionally developed.

Potato agar plus 5 *per cent. dextrose :* Aerial mycelium scant to moderate in amount, white to shell pink. Growth on substratum became wrinkled white to flesh colour, with patches of dark delft blue, which, after 14 days spread all over the slant, and in 8 weeks became almost black. The agar was stained dull Indian purple.

Potato plug : Plug covered with a mycelium which was cottony, white tinged lilac; or felt-like and wrinkled, pale salmon colour to seashell pink. The colour faded with age, and patches of deep delft blue appeared on the substratum; occasionally a few minute sclerotia developed. Sporodochia very numerous, pale salmon colour to light pinkish cinnamon, well developed after 4 weeks.

Melilotus stem : Stems covered with a short, white, felt-like mycelium. Sporodochia developed after 14 days; they were very numerous, scattered or in groups, minute, buff pink to light pinkish cinnamon.

Bean pod : Pods covered with a fair amount of white mycelium, which was cottony, or tomentose to sericeo-tomentose. Sporodochia developed in groups after 14 days, and were small, pale ochraceous buff.

Rice : Growth at first white to venetian pink and alizarine pink, or pale vinaceous later white to vinaceous and old rose. A few sclerotial bodies developed against the glass Cultures were aromatic, with an odour resembling lilac.

Measurements of Conidia.

Hard potato agar, culture 4 weeks old, conidia from pionnotes.

5-septate............	1 per cent..........	35–52·5 × 3·75–5.
4-septate............	3 ,, ...	35–52·5 × 4–4·5.
3-septate............	90 ,, ...	25–47·5 × 3·7–4·5.
1-septate............	1 ,,	
0-septate............	4 ,,	

Oat agar, culture 4 weeks old, conidia from sporodochia.

5-septate............	7 per cent..........	37·5–47·5 × 3·7–4·5.
4-septate............	15 ,, ...	35–42·5 × 3·7–4·5.
3-septate............	73 ,, ...	30–47·5 × 3·7–4·5.
0-septate............	5 ,,	

Melilotus stem, culture 4 weeks old, conidia from sporodochia.

4-septate............	0·5 per cent........	30–40 × 3·7–4·5.
3-septate............	92 ,, ...	20–45 × 3·5–4·5.
2-septate............	0·5 ,,	
1-septate............	1 ,,	
0-septate............	6 ,,	

Bean pod, culture 4 weeks old, conidia from sporodochia.

5-septate............	1	per cent........	40–42 × 4·5.
4-septate............	2·5	,, ...	35–38 × 3·7–4·5.
3-septate............	73	,, ...	22·5–40 × 3·2–4.
2-septate............	0·5	,, ...	15–17·5 × 3·2–3·5.
1-septate............	3	,, ...	15–17·5 × 2·7–3.
0-septate............	20	,, ...	3·2–10 × 2·5–3.

Fusarium vasinfectum Atk. var. **zonatum** (Sherb.) **f. 1.** (Lk. et Bail.) Wr.

Wollenweber, Fusarium-Monographie 425, 1931; Fus. aut. del. 629, 1021. Wollenweber and Reinking, Die Fusarien, 126, 1935.

Syn. *Fusarium cepæ* Walker et Tims.

F. zonatum (Sherb.) *f.1* Lk. et Bail.

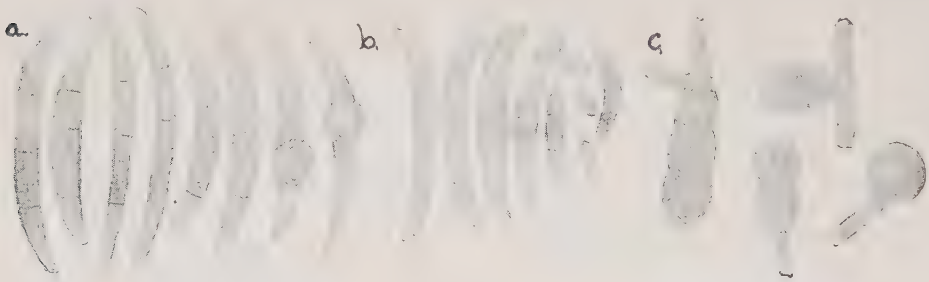

Fig. 41.

Fusarium vasinfectum Atk. v. zonatum (Sherb.) *f.*1 (Lk. et Bail) Wr. conidia from (*a*) sporodochia of - weeks old culture on Melilotus, and (*b*) thin pionnotes of 8 weeks old culture on oat agar, (*c*) chlamydospores from 12 weeks old culture on hard potato agar.

Differs from *F. vasinfectum* and its other varieties in the colour of the stroma and the conidial masses; growth on some media in concentric zones. Stroma pale, cream-coloured to salmon ochre, seldom purple red. Dark blue sclerotia and sclerotial stroma absent, but occasionally in cultures there occur erumpent, blister-like, raised, dark brown knots of plectenchyma from 0·5 mm. diam. Chlamydospores abundant; microconidia scattered in the aerial mycelium; macroconidia in salmon buff to ochraceous salmon pionnotes and sporodochia.

3-septate............	27·2–46·5 × 2·8–4·6	Average 37 × 3·8.
4-septate............	34·4–50 × 3·2–4·6...	Average 41·5 × 4.
5-septate............	37–50 × 3·3–4·6.....	Average 43·4 × 4.

The fungus is aromatic.

Hab. *Lycopersicum esculentum* Mill., from stems of wilting plants, Matatiele, E. Griqualand (Wager) M.H. 28387.

This fungus is known as a cause of bulb rot of onions, and also occurs on carrot, tomato and tulip in North America and Europe.

Growth on Standard Media.

Oat agar: Aerial mycelium sparse, white, cottony, mostly on the lower part of the slant. Growth on substratum colourless. Pionnotes developed more or less freely; they were salmon buff to ochraceous salmon.

Hard potato agar: Aerial mycelium sparse, short, white, rather coarse. Growth on substratum colourless. Pionnotes developed slowly.

Standard synthetic agar plus starch: No aerial mycelium. Growth on substratum colourless to pale ochraceous buff. Pionnotes developed slowly.

Potato agar plus 5 *per cent. dextrose :* Slant covered with a very small quantity of white, cottony mycelium. Growth on substratum tinged pale to light vinaceous purple, shading after 14 days to russet vinaceous. After 8 weeks, the agar was stained purplish brown.

Potato plug : Plugs covered with a moderate amount of aerial mycelium. No conidial masses developed in the cultures studied.

Melilotus stem : Stems covered with a short, white, felt-like mycelium. Sporodochia developed in groups after 4 weeks ; they were salmon buff to light ochraceous salmon.

Bean pod : Pods covered with a short, white, felt-like mycelium, with patches of longer, cottony hyphae at the top. No conidial masses developed in the cultures studied.

Rice : Growth white to flesh pink or salmon buff. The culture was aromatic.

Measurements of Conidia.

Melilotus stem, culture 8 weeks old, conidia from sporodochia.

5-septate............	0·5 per cent........	33–45 × 3–4·5.
4-septate............	2 ,, ...	23–45 × 3·5–4·5.
3-septate............	96·5 ,, ...	22·5–49 × 3·3–4.
2-septate............	0·5 ..	
0-septate............	0·5 ..	

Oat agar, culture 4 weeks old, conidia from pionnotes.

5-septate............	2·5 per cent........	40–48 × 3·5–4·5.
4-septate............	7 ,, ...	40–46 × 3·7–4.
3-septate............	63 ,, ...	25–42·5 × 3–4·5.
2-septate............	3·5 ,, ...	13–18 × 2·5–3·5.
1-septate............	2 ,, ...	12–15 × 2·5–3.
0-septate............	22 ,, ...	5–12 × 2–3.

Fusarium vasinfectum Atk. var. **zonatum** (Sherb.) **f. 2** (Lk. et Bail.) Wr.

Wollenweber, Fusarium-Monographie, 425, 1931 ; Fus. aut. del. 1021. Wollenweber and Reinking, Die Fusar en, 126, 1935.

Syn. *Fusarium zonatum* (Sherb.) Wr. *f.* 2 Lk. et Bail.

Fig. 42.

Fusarium vasinfectum Atk. v. *zonatum* (Sherb.) *f.*2 (Lk. et Bail.) Wr. ; conidia from sporodochia of 4 weeks old cultures on (*a*) oat agar, (*b*) standard synthetic agar plus starch, (*c*) potato plug and (*d*) Melilotus stem.

This fungus is only slightly aromatic, has no sclerotia, and differs from *f.* 1 in the red, almost purple, stroma, a lilac-tinted aerial mycelium and freely produced pionnotes. Conidia 3–6-septate, predominantly 3-septate ; 3-sept. 38·5 × 3·7 ; 5-sept. 42·1 × 4·1. Chlamydospores abundant in mycelium and conidia.

Hab. *Allium cepa* L., from bulbs (scales showing light brown discolouration, moderately firm to soft), Nelspruit (Wager) and Pretoria (Wager) M.H. 28407 ; from leaf bases of wilting plants, Nelspruit (Wager), and Eikenhof, near Johannesburg, October 1932.

This form occurs in North America, where it is a cause of bulb rot in onions. It also occurs on beet.

Growth on Standard Media.

Oat agar : Aerial mycelium short, sparse, white or tinged lilac. Growth on substratum deep vinaceous lavender to dull Indian purple. Numerous small sporodochia developed; they were light ochraceous salmon and 1–2 mm. in diameter.

Hard potato agar : Aerial mycelium sparse to moderate in amount, mostly short, longer at the top and bottom of the slant. Growth on substratum colourless. A thin pionnotes developed over the surface of the slant.

Standard synthetic agar plus starch : Aerial mycelium scanty. Growth on substratum tinged vinaceous lavender. A few, light ochraceous salmon sporodochia developed near the base of the slant.

Potato agar plus 5 *per cent. dextrose :* Aerial mycelium short, felt-like, white to lavender. Growth on substratum vinaceous lavender to dull Indian purple. After some time the growth became wrinkled.

Potato plug : Cylinder covered with a fairly copious growth of white, cottony mycelium, which tended to become wrinkled and felt-like on the face of the plug. Very numerous, small, ochraceous salmon sporodochia developed. In many cases, these seemed to arise from small, brown to blackish masses of plectenchyma.

Melilotus stem : Mycelium scant, white to dirty white, very short and felt-like, or sericeo-tomentose in coarse tangled strands. Numerous small sporodochia developed, and also pionnotes; these were pinkish cinnamon to ochraceous salmon.

Bean pod : Aerial mycelium moderate in amount, coarse, white, tomentose. Numerous small sporodochia developed; they were scattered or in groups, and pinkish cinnamon to ochraceous salmon in colour.

Rice : Aerial mycelium at first white to vinaceous lilac, becoming rhodomite pink. Growth on grains was vinaceous lilac to deep purplish vinaceous, becoming neutral red, and finally alizarine pink to acajou red. Numerous small plectenchymatous masses formed against the glass; they became brownish, then sepia to almost black. The culture was slightly aromatic.

Measurements of Conidia.

Oat agar, culture 4 weeks old, conidia from sporodochia.

5-septate............	5 per cent..........	42·5–52·5 × 3·7–4.
4-septate............	22 ,, ...	35–52·5 × 3·25–4.
3-septate	70 ,, ...	27·5–52·5 × 3·25–4, mostly 35–40 long.
0-septate............	3 ,,	

Potato plug, culture 4 weeks old, conidia from sporodochia.

5-septate............	1 per cent..........	37·5–45 × 3·75–4.
4-septate............	5 ,, ...	30–40 × 3–4.
3-septate............	72 ,, ...	30–42·5 × 3–4.
1-septate............	1 ,, ...	8–17·5 × 2–3·5.
0-septate............	21 ,, ...	5–10 × 2–3·25.

Melilotus stem, culture 8 weeks old, conidia from sporodochia.

5-septate............	1·5 per cent........	37·5–45 × 4–4·5.
4-septate............	5 ,, ...	35–45 × 3·5–4·5.
3-septate............	91·5 ,, ...	25 42·5 × 3·5–4.
0-septate............	2 ,,	

Chlamydospores formed in many of the conidia.

Fusarium redolens f.1. Wr.

Wollenweber, Fusarium-Monographie, 426, 1931 ; Fus. aut. del. 1022. Wollenweber and Reinking, Die Fusarien, 127, 1935.

Microconidia 1-celled, 9 × 3, or 1-septate, 16 × 4·5. Macroconidia 3-septate, less frequently 4-septate, exceptionally 5-septate, fusiform-falcate, curved, sometimes recalling

those of *F. solani*, but, in the more compact conidial forms, somewhat thicker in the upper third than in the middle; gradually tapering towards the base, which is pedicellate or papillate. Conidia in sporodochia or pionnotes, brownish-white, cream-colour, or light flesh colour in mass.

3-septate............	17–51 × 3–6·5.......	Mostly 29–43 × 3·7–5·5.
5-septate............	31–61 × 3·5–6·5.....	Mostly 37–47 × 4–6.

Chlamydospores terminal and intercalary, 1-celled 3-12, (mostly 6 9) 2-celled 11–24 × 5 14, (average 14 × 8·2), smooth or rough, in conidia or mycelium. Blue sclerotia wanting. Plectenchymatous stroma effuse, pale, pinkish white or lilac colour. The fungus is not aromatic.

Hab. *Lycopersicum esculentum* Mill., from seed offered for sale (Wager).

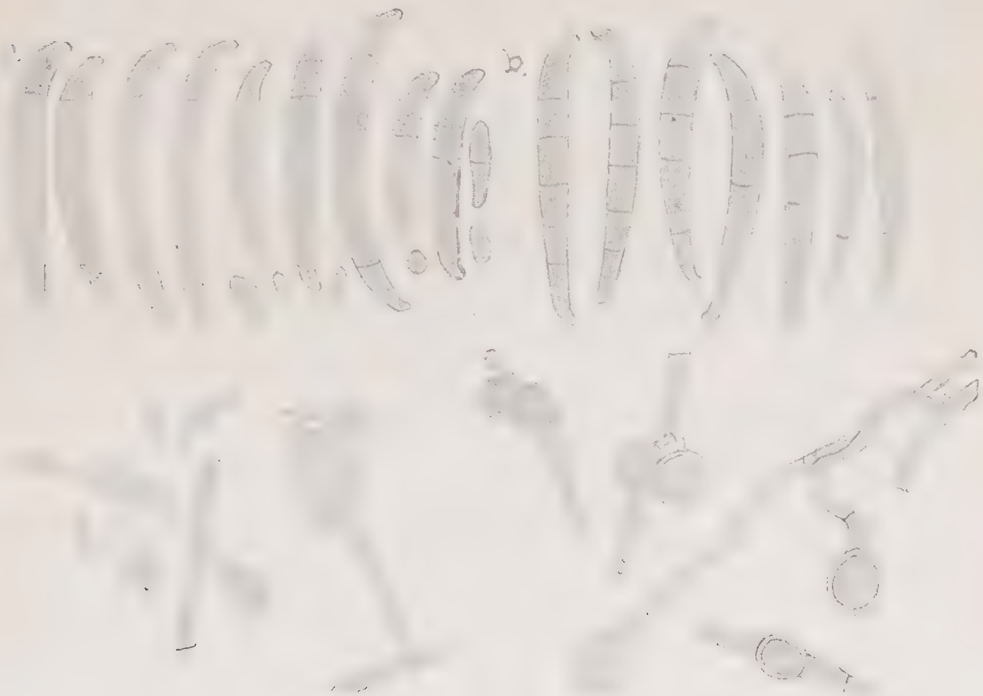

Fig. 43.

*Fusarium redolens f.*1 Wr.; conidia from (*a*) sporodochia of 2 weeks old culture on Melilotus stem, and (*b*) pionnotes of 6 days old plate culture on plain agar, (*c*) microconidia and chlamydospores from plain agar plates, 6 days old.

Growth on Standard Media.

Oat agar: Aerial mycelium sparse, white to shell pink. Growth on substratum buff pink to onion skin pink. Pionnotes well developed, pale pinkish cinnamon or pinkish cinnomon to orange cinnamon.

Hard potato agar: Aerial mycelium scanty to none. Growth on substratum colourless. A few small sporodochia formed near the base of the slant.

Standard synthetic agar plus starch: No aerial mycelium. Growth on substratum colourless or tinged cinnamon. Sporodochia at first tilleul buff, becoming pale ochraceous buff when well developed.

Potato agar plus 5 *per cent. dextrose:* Aerial mycelium scant, white, in patches. Growth on substratum colourless. Pionnotes pale cinnamon pink.

Potato plug : Plug covered with a matted mycelium, which was tilleul buff to pale vinaceous fawn, and became wrinkled when cultures were 3 weeks old. Conidial masses developed between the medium and the glass.

Melilotus stem : Aerial mycelium scanty, white. Sporodochia tilleul buff to light pinkish cinnamon, not very large, and scattered or in groups.

Bean pod : Pod covered with a copious aerial mycelium, which was white to pallid vinaceous drab to pale vinaceous fawn. Growth became wrinkled and felt-like.

Rice : Growth white to pale flesh colour. Small, white plectenchymatous bodies formed between the medium and the glass. The culture was not aromatic.

Measurements of Conidia.

Oat agar, culture 19 days old, conidia from pionnotes.

3-septate............	42 per cent..........	29–45 × 6–6·25.
2-septate............	9 ,, ...	28–32·5 × 3·75–5.
1-septate............	17 ,, ...	22·5–29 × 3·7–6·25.
0-septate............	32 ,, ...	4·5–10·5 × 3·7–4·5.

Melilotus stem, culture 15 days old, conidia from sporodochia.

4-septate............	2 per cent........	40–44 × 5–6·25.
3-septate............	96·5 ,, ...	25–42·5 × 3·75–6.
2-septate............	0·5 ,, ...	21–22 × 4–5.
1-septate............	0·5 ,, ...	15–20 × 3·7–5.
0-septate............	0·5 ,, ...	7·5 × 3·75.

Standard synthetic agar plus starch, culture 8 weeks old, conidia from sporodochia.

4-septate............	0·5 per cent........	40–45 × 4–5·5.
3-septate............	99 ,, ...	28–38 × 4·8–6·3.
2-septate............	0·5 ,, ...	30–31 × 4·8–5.

The shorter conidia often stouter than the longer ones.

Plain agar plate, culture 6 days old.

5-septate................................	45–55 × 4–6.
4-septate................................	42·5–52·5 × 4–5·5.
3-septate................................	42·5–47·5 × 4–5.

Section MARTIELLA.

Wollenweber, Phytopathology, 3: 30, 1913. Wollenweber and Reinking, Die Fusarien, 127, 1935.

Fungi of this group are chiefly found in the soil and in subterranean parts of plants. Macroconidia dorsiventral, fusiform to falcate, thick-walled, curvature slight in the central part of the conidium, more decided near the apex; apex rounded or tapering; base subpedicellate or mammillate. The medial diameter of the macroconidia is of diagnostic value in this section. Microconidia mostly 1-celled, small, oval to oblong. Conidial masses pale, white, yellowish or brownish, or in older cultures darker, honey colour to amber, or becoming tinged with the colour of the stroma. Stroma yellow brown to dark blue, the brightest colours occurring on carbohydrate media. Sclerotial bodies erumpent on certain substrata, brown, green, violet or blue black. Chlamydospores usually produced freely, terminal or intercalary, developing in chains or clusters, smooth or rough.

It has been established that members of the genus *Hypomyces* represent the ascus stage of a few of the Martiella-Fusaria.

Key to the South African Species.

A.—Dorsiventrality of conidia distinct only at the apical end.
  a.—Conidia almost cylindrical to fusiform-falcate, obliquely conical or rounded at the apex; obtuse, mammillate or with an oblique papilla at the base.

b.—Conidia 3- (0–5) septate ; 3-sept. 34 × 4·8 ; 5-sept. 42 × 5·2 .... *F. coeruleum.*

AA.—Dorsiventrality of fusiform-falcate conidia distinct at both ends. Base mammillate to sub-pedicellate.

a.—Medial diameter of 3–5-sept. conidia 4–5 :

b.—Conidia in masses mostly 3-septate .... *F. javanicum* v. *radicicola.*

bb.—Conidia in masses mostly 3–5-septate .... *F. javanicum.*

aa.—Medial diam. of 3–5-sept. conidia 5–6 :

b.—Conidia in masses mostly 3-septate :

c.—Conidia 3-sept. 36 × 5·5 ; 5-sept. 49 × 5·3 *F. solani.*

cc.—Conidia 3-sept. 39 × 5 ; 5-sept. 49 × 5·3 *F. solani* v. *Martii f.* 1.

Fusarium javanicum Koord.

Koord, Verh. Koninkl. Akad. Wetensch. Amsterdam, 11, 13 : 247, 1907. Wollenweber, Fus. aut. del. 424, 426–428, 1025–1027. Wollenweber and Reinking, Die Fusarien, 131, 1935.

Syn. *Fusarium theobromae* App. et Strk. F. javanicum Koord. v. theobromae (App. et. shk.) Wv.

Fusarium heveae P. Henn. in herb. (non Vincens).

Fusoma glandarium Corda.

Conidia in mass brownish white to light brown ; when older, coffee brown, or tinged with the colour of the stroma. Stroma leathery to gelatinous, seldom sclerotial, usually olive green to olive brown. Microconidia 1-celled or septate, usually scattered freely in the aerial mycelium. Macroconidia in sporodochia and pionnotes, falcate, slightly curved often rather more decidedly curved at the apex, constricted at both ends, more or less pedicellate at the base, 3–5-septate, exceptionally 6–8-septate.

0-septate	8 × 3.	
1-septate	18 × 3·6.	
3-septate	22–54 × 3·5–6	Mostly 28–47 × 4–5.
5-septate	35–60 × 4–6	Mostly 40–56 × 4·5–5·3.
7-septate	60 × 5.	

Chlamydospores 1–2-celled, 5–8 μ diameter.

Hab. *Cucurbita Pepo* L., and *C. maxima* Duchesne ; from stems of wilting plants of pumpkin, marrow and Hubbard squash, Hennops River and Daspoort, Pretoria Dist. (Kresfelder) M.H. 28414 ; Uitenhage, Cape, Nov. 1935 (Haines.)

This fungus causes extensive damage in commercial plantings of pumpkin, marrow and squash. In other warm countries, *F. javanicum* is known as a rot-producing organism in coffee, cocoa, rubber, etc. It also occurs in the temperate zone on poplar and elm.

Growth on Standard Media.

Oat agar : Aerial mycelium scant to none. Very numerous, minute sporodochia developed, which coalesced more or less completely to form a continuous pionnotes ; the conidial masses were cream buff, and developed in irregular patches. Growth on substratum colourless to wood brown.

Hard potato agar : Mycelium not abundant, rather coarse, short, white to ivory yellow. Sporodochia numerous, minute, crowded, coalescing to form pionnotes, cream buff to chamois, often developing in concentric zones round the point of transfer. Pionnotes on this, and on other media, rather dry, and inclined to crumble when touched with a needle ; less frequently of the consistency of cream cheese.

Standard synthetic agar plus starch : Aerial mycelium scant to none. Conidial masses developed freely all over the surface of the slant, often in concentric zones round the point of transfer, cream buff to light pinkish cinnamon. Growth on substratum colourless, except at the base of the slant, where it was wood brown.

Potato agar plus 5 per cent. dextrose : Growth dense, felt-like, zoned, wood brown, avellaneous and cartridge buff, or citrine drab and yellowish olive. Pionnotes developed freely ; they were wood brown or tinged lincoln green.

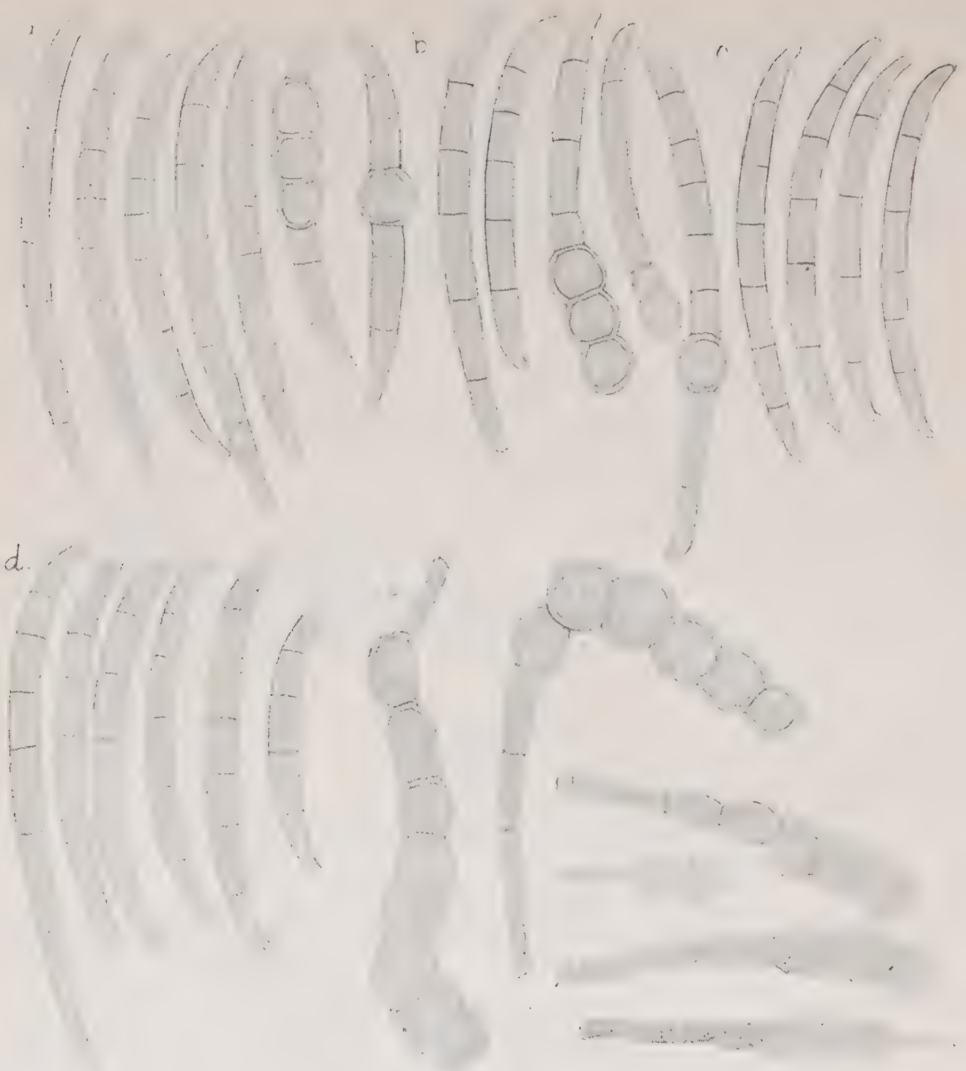

Fig. 44.

Fusarium javanicum Koord.; conidia from (*a*) mycelium of 19 days old culture on plain agar, (*b*) pionnotes of 4 weeks old culture on hard potato agar, (*c*) pionnotes of 5 weeks old culture on oat agar, (*d*) sporodochia of 2 weeks old culture on bean pod, (*e*) chalmydospores from 4 weeks old culture on oat agar, and (*f*) from culture 8 weeks old on Melilotus stem.

Potato plug : Aerial mycelium very sparse, white, cottony; sometimes a few white tufts of mycelium appeared near the top of the plug. The rest of the cylinder became covered with conidial masses; these consisted of very numerous, minute, crowded sporodochia, which coalesced to form a dense pionnotes. Conidial masses at first cartridge buff, becoming pinkish buff to sage green, and in places dark bluish glaucous to Russian green.

Melilotus stem : Mycelium sparse, white to cartridge buff. Conidial masses developed freely; they were chamois to cinnamon buff. Numerous minute, black sclerotia formed under the mycelium.

Bean pod : Mycelium white, felt-like, wrinkled. Conidial masses formed a thick crust, which was at first chamois, and later chamois to cinnamon buff.

Rice : Aerial mycelium tilleul buff. Growth on grains vinaceous buff to avellaneous. Grains were army brown to Natal brown.

Measurements of Conidia.

Hard potato agar, culture 2 weeks old, conidia from pionnotes.

6-septate............	2	per cent........	$67 \cdot 5–80 \times 5$.
5-septate............	45	,, ...	$57 \cdot 5–75 \times 4 \cdot 5–5 \cdot 5$.
4-septate............	8	,, ...	$47 \cdot 5–67 \cdot 5 \times 4 \cdot 5–5$.
3-septate............	12	,, ...	$25–50 \times 3 \cdot 7–4 \cdot 5$.
2-septate............	0·5	,, ...	$20–27 \cdot 5 \times 3 \cdot 7–5$.
1-septate............	17	,, ...	$12 \cdot 5–17 \cdot 5 \times 3 \cdot 5–5$.
0-septate............	15·5	,, ...	$10 \cdot 5–12 \cdot 5 \times 3 \cdot 5–4$.

Oat agar, culture 5 weeks old, conidia from pionnotes.

5-septate............	28	per cent........	$60–75 \times 4 \cdot 7–5$.
4-septate............	59	,, ...	$55–69 \times 3 \cdot 7–5$.
3-septate............	3	,, ...	$45–62 \cdot 5 \times 3 \cdot 7–4 \cdot 7$.
2-septate............	1·5	,,	
1-septate............	4·5	,,	
0-septate............	4	,,	

Potato plug, culture 4 weeks old, conidia from pionnotes.

5-septate............	12·5	per cent........	$47 \cdot 5–62 \cdot 5 \times 4–4 \cdot 5$.
4-septate............	56	,, ...	$45–52 \cdot 5 \times 4–4 \cdot 5$.
3-septate............	19	,, ...	$30–52 \cdot 5 \times 3 \cdot 7–4 \cdot 5$.
2-septate............	1·5	,, ...	$27 \cdot 5–45 \times 4–4 \cdot 5$.
1-septate............	6·5	,, ...	$17 \cdot 5–22 \cdot 5 \times 3–4$.
0-septate............	4·5	,, ...	$7 \cdot 5–15 \times 3 \cdot 7–4$.

Melilotus stem, culture 4 weeks old, conidia from pionnotes.

5-septate............	2·5	per cent........	$55–57 \cdot 5 \times 4–5$.
4-septate............	30	,, ...	$45–52 \cdot 5 \times 4–5$.
3-septate............	13·5	,, ...	$42 \cdot 5–47 \cdot 5 \times 3 \cdot 7–4 \cdot 5$.
2-septate............	2·5	,, ...	$20–32 \cdot 5 \times 3–3 \cdot 75$.
1-septate............	19	,, ...	$12 \cdot 5–21 \times 3–4 \cdot 5$.
0-septate............	32·5	,, ...	$6 \cdot 25–12 \cdot 5 \times 3–4$.

Standard synthetic agar plus starch, culture 4 weeks old, conidia from pionnotes.

5-septate............	7	per cent..........	$42 \cdot 5–67 \cdot 5 \times 5$.
4-septate............	43	,, ...	$37 \cdot 5–70 \times 3 \cdot 7–5$.
3-septate............	25	,, ...	$35–65 \times 3 \cdot 7–5$.
2-septate............	1	,, ...	$33 \cdot 75 \times 4 \cdot 4$.
1-septate............	11	,,	
0-septate............	13	,,	

Chlamydospores common in mycelium and conidia. In oat agar plates 4 weeks old, they were commonly in simple or irregular chains of 2 to 9 elements ; these were mostly terminal. Intercalary chlamydospores were often solitary. Single spores $7 \cdot 5–12 \cdot 5\ \mu$ diameter. They were sometimes in loose groups, but were never seen in closely united packets as in *F. solani*. In hard potato agar plates, 4 weeks old, chlamydospores were forming in a large proportion of the conidia. These were terminal (often in the basal cell or cells) or intercalary ; they were single, in pairs, or rarely in chains of 3 to 4 elements ; thick walled, rough when mature, $5 \cdot 6–11 \cdot 25$ diam.

Fusarium javanicum Koord. var. **radicicola** Wr.

Wollenweber, Fusarium-Monographie, 286, 1931; Fus. aut. del. 423, 632, 1023, 1024. Wollenweber and Reinking, Die Fusarien, 129–130, 1935.

Syn. *Fusarium radicicola* Wr.

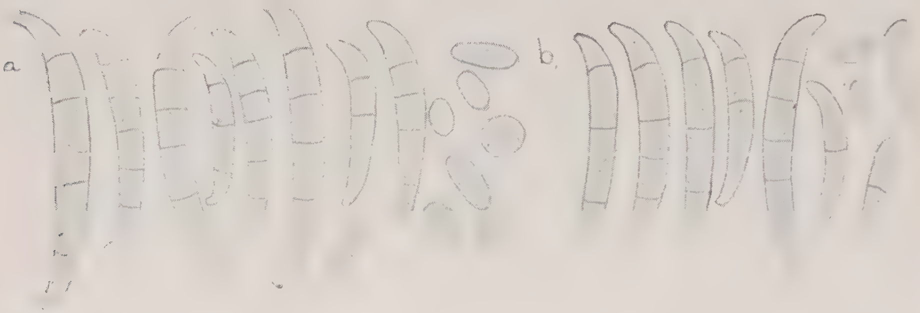

Fig. 45.

Fusarium javanicum Koord. v. *radiciola* Wr.; conidia from pionnotes of culture on (*a*) potato plug, (*b*) bean pod; both cultures 4 weeks old.

Microconidia numerous, 1-celled or septate, scattered in the mycelium, or cohering in false heads. Macroconidia in sporodochia, or less frequently in pionnotes, brownish white in mass, becoming darker with age, or taking up colour from the olive green or coffee brown stroma. Macroconidia 3-septate, less frequently 4-, and exceptionally 5-septate, elongated, slightly curved, somewhat more definitely curved, and constricted at the apex, sub-pedicellate at the base.

0-septate............	4–15 × 1·7–4·5......	Mostly 6·3–10 × 2–3.
1-septate............	8–27 × 3–5..........	Mostly 13–17 × 3·7–4·3.
3-septate............	20–50 × 3·4–5·3.....	Mostly 30–42 × 3·8–4·8.
5-septate............	38–59 × 4–5·3.......	Mostly 43–46 × 4–5·1.

Chlamydospores common, terminal and intercalary, 1–2-celled, in chains or clusters; 1-celled 9–10 × 8·5–9; 2-celled 16–22 × 5–12; smooth or rough.

Hab. *Pelargonium* sp., from discoloured rhizome, Pretoria (Wager).

Solanum tuberosum L., from tubers showing a black form of dry rot, Umhlanga Beach, near Mt. Edgecombe, Natal, Jan. 1931 (van der Plank).

This fungus is known in the United States as a cause of potato rot; it is also found in other root crops, and in ornamental plants.

Growth on Standard Media.

Oat agar: Aerial mycelium short, sparse, white, tomentose. Growth on substratum colourless. Conidial masses did not develope freely on this medium. Reinking and Wollenweber (39) record the development on oat agar of "olive buff and pea green sporodochia in large heaps, gradually forming a pionnotes."

Hard potato agar: Mycelium not abundant, rather coarse, tomentose, short. Sporodochia, when present, in groups, cream buff to olive buff and lichen green; often forming in concentric rings. In some old cultures, the agar was stained Natal brown.

Standard synthetic agar plus starch: Slant covered with short, white mycelium, which was mealy-looking owing to the presence of numerous conidia. Growth on substratum colourless to wood brown.

Potato agar plus 5 *per cent. dextrose:* Aerial mycelium scant, short, mealy-looking. Growth on substratum buff pink to vandyke brown; agar stained Japan rose.

Potato plug : Aerial mycelium rather coarse, short, tomentose or felt-like, white to cream buff and buff pink, or, when older, tilleul buff to buff pink and vinaceous brown ; brown in places after 12 weeks. Sporodochia in groups, at first vinaceous buff, then olive buff and light terre verte.

Melilotus stem : Stems covered with a rather short, white, coarse, tomentose mycelium. Sporodochia and pionnotes developed in longitudinal lines ; they were pinkish buff to dark olive buff.

Bean pod : Pods covered with a rather sparse, coarse mycelium, which was white to pale cinnamon pink. Pinkish buff sporodochia and pionnotes developed in patches.

Rice : Aerial mycelium short, white, mealy ; growth on substratum purplish vinaceous to dark livid brown and wood brown.

Measurements of Conidia.

Melilotus stem, culture 4 weeks old, conidia from sporodochia.

5-septate	6 per cent	40–59 × 4·5–5·5.
4-septate	16 ,,	35–48 × 3·7–5.
3-septate	26 ,,	22·5–42 × 3·7–5.
2-septate	4 ,,	20–27·5 × 3·7–4.
1-septate	9 ,,	15–20 × 3·2–4.
0-septate	39 ,,	5–12·5 × 3–3·75.

Potato plug, culture 4 weeks old, conidia from mycelium.

5-septate	16·5 per cent	35–52·5 × 4·5–5·5.
4-septate	7·5 ,,	32·5–40 × 4·5–4·3.
3-septate	8 ,,	20–32·5 × 4–5.
2-septate	0·5 ,,	16–18 × 3·7–5.
1-septate	1·5 ,,	12·5–17·5 × 3–5.
0-septate	66 ,,	3·75–10 × 3·2–5·5.

Bean pod, culture 2 weeks old, conidia from pionnotes.

5-septate	Rare	40–57·5 × 5.
4-septate	0·5 per cent	39–52·5 × 5.
3-septate	27 ,,	22·5–45 × 3·7–5.
2-septate	16 ,,	
1-septate	14 ,,	
0-septate	42·5 ,,	

Non-septate conidia oval, pyriform or spherical; 1-septate usually comparatively slender, but occasionally resembling the 1-celled conidia in form.

Fusarium solani (Mart.) App. et Wr.

Appel and Wollenweber, Arb. K. Biol. Anst. Land.- u. Forstw. 8 : 65–78, 1910. Wollenweber, Fus. aut. del. 396–400, 404, 405, 418–421, 1029, 1031–1033, 1194. Wollenweber and Reinking, Die Fusarien, 135, 1935.

Syn. *Fusisporum solani* Martius pro parte.

Fusisporum solani Mart. v. *flavum* Hart.

Fusisporum solani-tuberosi Desm. ; *Pionnotes solani-tuberosi* (Desm.) Sacc.

Fusarium commutatum Sacc.

Lachnidium acridiorum (Trab.) Giard. ; *Fusarium acridiorum* (Trab.) Brougn. et Del.

Fusarium allii-sativi All. ; *F. alluviale* Wr. et Rkg. ; *F. Malli* Taub.

F. solani (Mart.) v. *cyanum* Sherb. ; *F. solani* (Mart.) *f.* 1 Wr.

F. solani (Mart.) v. *medium* Wr. ; *F. solani* (Mart.) v. *suffuscum* Sherb.

F. viride (Lechm.) Wr. ; *Pionnotes viridis* Lechm.

Conidia scattered, in false heads, in sporodochia or in pionnotes, in mass brownish white to clay yellow, or tinged with blue, or flecked with green from the stroma. Stroma leathery, or sclerotial, green to dark blue. Macroconidia almost cylindrical-fusiform,

slightly curved, rounded at both ends, or tapering and bluntly conical; base with a scarcely-perceptible papilla, which is oblique to the longitudinal axis, seldom sub-pedicellate, 3 or 3–5-septate.

0-septate	11 × 3·8.	
1-septate	20 × 4·3.	
3-septate	19–50 × 3·5–7	Mostly 28–42 × 4·1–6·2.
4-septate	42 × 5·6.	
5-septate	32–68 × 4–7	Mostly 42–51 × 5–6·3.

Chlamydospores terminal and intercalary, brownish, single, spherical to pear-shaped; 1-celled 8·5 × 8; 2-celled 9–16 × 6–10; seldom in chains and clusters, smooth, or sometimes minutely verrucose, and rough when dry.

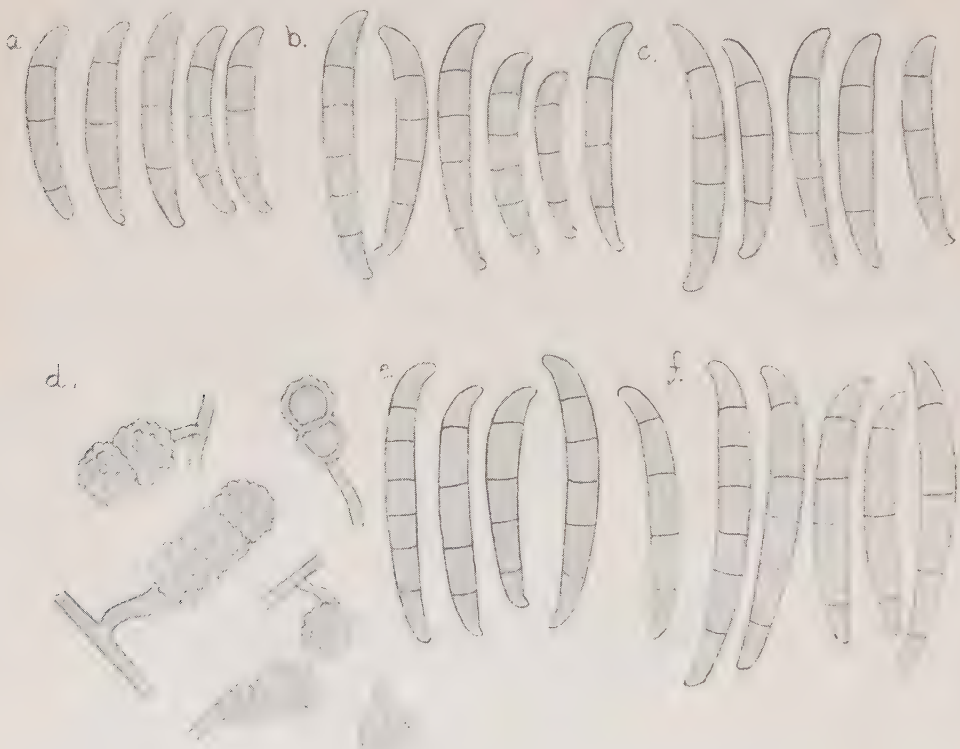

Fig. 46.

Fusarium solani (Mart. pr. p.) App. et Wr.; (*a-d*) strain from wheat, (*e-f*) from collar rot of orange tree; conidia from (*a*) sporodochia of 4 weeks old culture on Melilotus stem (band e) pionnotes of 3 weeks old cultures on hard potato agar, (*c* and *f*) pionnotes of 5 weeks old cultures on oat agar, (*d*) chlamydospores from 8 weeks old culture on hard potato agar.

Hab. *Allium cepa* L., from discoloured bulbs, and stems of dying plants, Nelspruit (Wager) M.H. 28383. Also recorded by du Plessis (11) as causing a dry rot of onions in storage, Stellenbosch, Cape.

Carica papaya L., from stem of plant affected by foot rot, Maritzburg, Natal (Wager); Malelane, E. Transvaal (Wager) M.H. 28375 and 28374.

Citrus grandis Osbeck, from bark of grapefruit tree showing gummosis, Patentie, Cape (van der Plank) M.H. 28401; Coegapoort, Gamtoos Valley, Cape (van der Plank) 1930 (from collar of 2-year old tree).

Citrus limonia Osbeck, from roots of lemon stocks on which orange or grapefruit had been budded, roots showing "dry root rot" lesions; Louis Trichardt, N. Transvaal; Bathurst dist., Cape (van der Plank); Thorndale, Hankey, Cape (van der Plank) M.H. 28371; Acornhoek, E. Transvaal, M.H. 28396; Tzaneen, N. Transvaal (Wager); Elandshoek, E. Transvaal, M.H. 28372; Coegapoort, Gamtoos Valley, Cape, 1930 (van der Plank). Also from soil in Citrus orchard Kosterfontein, Marico dist., Transvaal (Esselen).

Citrus sinensis Osbeck, from bark above union, which was cracking and gumming (roots waterlogged) Letaba Estates, N. Transvaal; from bark of tree affected with scaly bark (psorosis) Mazoe Estates, S. Rhodesia (Bates); from roots of old seedling orange, Viliersdorp, Cape, M.H. 28360.

Dianthus caryophyllus L., from stem of plant affected with crown rot (ass. *F. bulbigenum* v. *lycopersici*) Pretoria.

Gilia rubra Heller, from stems of wilting plants, Acton Homes, Natal

Gladiolus sp., from corms showing a dry brown rot (ass. *F. oxysporum* v. *gladioli*) Princess Park, Pretoria.

Phaseolus sp., from stems of dying plant, Swaziland (Wager).

Solanum tuberosum L., from tubers showing dry rot and soft rot in a consignment imported from Germany. Also isolated by du Plessis (13) from rotting tubers, Ceres, George, Paarl and Stellenbosch, Cape.

Tropaeolum majus L., from stem of dying plant, Pretoria.

Zea mays L., from base of stem of plant showing foot rot (ass. *F. moniliforme*) Waterberg, Transvaal (Sellschop).

Fusarium solani is a rotting organism and is seldom a primary cause of injury. It occurrs on a wide range of plants, chiefly in the temperate zone.

Growth on Standard Media.

Oat agar : Aerial mycelium sparse, rather coarse, tomentose, white or dirty white. Conidial masses developed freely; pionnotes and sporodochia at first cartridge buff, becoming pinkish buff, and in older cultures stained bluish grey green to dark russian green. Sporodochia were produced in large groups.

Hard potato agar : Some rather coarse, scant, white, tomentose mycelium developed over the face of the slant, sometimes becoming mealy owing to the formation of conidia, and sometimes showing concentric zoning. Pionnotes developed freely and groups of sporodochia near the base of the slant; spore masses were at first cartridge buff, becoming pinkish buff and dark bluish glaucous.

Standard synthetic agar plus starch : Aerial mycelium short, scant white. Pionnotes developed freely, especially along the needle track; they were cartridge buff. A few, small, blackish-brown sclerotia appeared near the base of the slant.

Potato agar plus 5 *per cent. dextrose :* Mycelium moderate in amount, at first white to cartridge buff. Growth on substratum cream to sage green, becoming dark olive to clove brown. In older cultures the mycelium became tinged with the colour of the stroma. A number of blackish-brown sclerotia developed at the base of the slant.

Potato plug: Plug covered with a moderate amount of rather coarse mycelium, wnich was white to dirty white; there were a few patches and flecks of dark terre verte at the base and back of the plug. Large groups of sporodochia were usually produced, and coalesced to form a pionnotal mass; spore masses were at first cartridge buff to pinkish buff, and later tinged bluish grey green to glaucous or deep lichen green. In some tubes a few small, dark brown sclerotial masses developed.

Melilotus stem : Mycelium sparse, loose, coarse, white to dirty white. Pionnotes and groups of sporodochia were pinkish buff to deep bluish glacious. A few dark brown sclerotial masses were present.

Bean pod : Mycelium rather plentiful, or sparse, coarse, tomentose or becoming wrinkled and felt-like, white to cartridge buff. Large sporodochia developed in groups ; they were cartridge or pinkish buff to deep bluish grey green.

Rice : Growth white to light purple drab ; grains white to naples yellow.

Measurements of Conidia.

Oat agar, culture 4 weeks old, conidia from pionnotes.

5-septate............	1 per cent........	38–50 × 5–5·5.
4-septate............	25 ,, ...	37·5–50 × 5–6·25.
3-septate............	73·5 ,, ...	30–42 × 5–5·5.
1-septate............	0·5 ,,	

Bean pod, culture 4 weeks old, conidia from sporodochia.

5-septate............	2 per cent..........	37·5–50 × 5–5·6.
4-septate............	43 ,, ...	32·5–45 × 5.
3-septate............	51 ,, ...	27·5–50 × 5–5·5, mostly 30–40 × 5.
0-septate............	4 ,,	

Hard potato agar, culture 3 weeks old, conidia from pionnotes.

5-septate............	1·5 per cent........	36·2–45 × 5.
4-septate............	16 ,, ...	25–42·5 × 5.
3-septate............	81 ,, ...	27·5–42·5 × 4·7–5.
1-septate............	1·5 ,,	

Oat agar, culture 2 weeks old, conidia from sporodochia.

5-septate............	Rare................	47·5 × 5.
4-septate............	6 per cent.	35–45 × 4–5
3-septate............	79 ,, ...	35–40 × 4–5.
2-septate............	9 ,, ...	22·5–30 × 3·7–4.
1-septate............	2·5 ,, ...	15–20 × 3·7–4.
0-septate............	3·5 ,, ...	7·5–15 × 2·5–3·75.

Fusarium solani (Mart.) v. **Martii** (App. et Wr.) **f. 1.** Wr.

Wollenweber, Fusarium-Monographie, 290, 1931 ; Fus. aut. del. 415–417, 631. Wollenweber and Reinking, Die Fusarien, 137, 1935.

Syn. *Fusarium Martii* App. et Wr. v. *minus* Sherb.

Fusarium Martii App. et Wr. v. *viride* Sherb.

? *Fusarium pestis* Sor.

Conidia more slender than those of *Fusarium solani*, with hardly any curvature in the medial portion, more definitely curved or bent near the apex, base papillate or sometimes pedicellate. Macroconidia 3-septate, more rarely 4-septate, exceptionally 5-septate ; microconidia 0–2-septate.

0-septate............	8 × 3·8.	
1-septate............	17 × 4·5.	
3-septate............	22–52 × 3·5–6.......	Mostly 30–44 × 4·5–5·5.
4-septate............	46 × 5·2.	
5-septate............	39–62 × 4·2–6.......	Mostly 43–57 × 4·3–5·5.

Conidia in mass brownish-white, or ivory yellow to light brown ; often absorbing colour from the greenish blue or brown stroma, and then with a mixture of wood brown, grey and coffee brown to blackish tones. Chlamydospores in conidia 8·5 × 6; in mycelium 1-celled, 10 × 8, 2-celled 8–22 × 6–12.

Hab. *Allium cepa* L., from rotting bulb, Pretoria, 1932 (Bottomley).

Carica papaya L., from stems of plants showing foot rot, Maritzburg, Natal (Wager) ; Buffelspoort, Marikana, W. Transvaal (Wager) M.H. 28373 ; Nelspruit, E. Transvaal (Wager).

Centaurea moschata L., from stems of wilted plants, Pretoria (Wager).

Citrus grandis Osbeck, from bark of tree showing gummosis, Patentie, Cape (van der Plank).

Citrus limonia Osbeck, from roots of lemon stocks on which orange grapefruit or naartje had been budded, roots showing "dry root rot" lesions; Grahamstown, Cape (van der Plank) M.H. 28376; Godwan River, E. Transvaal, Oct. 1930 (Marloth); Swanepoelsrust, near Nylstroom, M.H. 28366; Plaston, E. Transvaal (Esselen); White River, E. Transvaal; Buffelspoort, Marikana (Turner); Elizabethville, Belgian Congo, M.H. 28367; Avonmore, Rustenburg dist., and Kosterfontein, Marico dist., W. Transvaal (Esselen); Addo, Cape, M.H. 28368; Magaliesburg, Transvaal, Nov. 1929 (van der Plank); Citrusdal, Cape (Turner) M.H. 28369; Airlie, E. Transvaal (van der Plank); White River (Esselen) M.H. 28370; Kakamas, Cape (Gutsche): Hankey, Cape (van der Plank); Kruis River, Cape, May 1930 (van der Plank) M.H. 28397; Louisvale, Cape (Turner) M.H. 28399; Amanzi, Cape, May 1930 (van der Plank) M.H. 28399; Ofcalaco, N. Transvaal July 1930 (van der Plank); Gamtoos Valley, Cape, Aug. 1930 (van der Plank); Elandshoek, E. Transvaal, July 1930.

Also from roots not visibly affected by root rot, and from the soil, Boskopjes, Rustenburg dist.

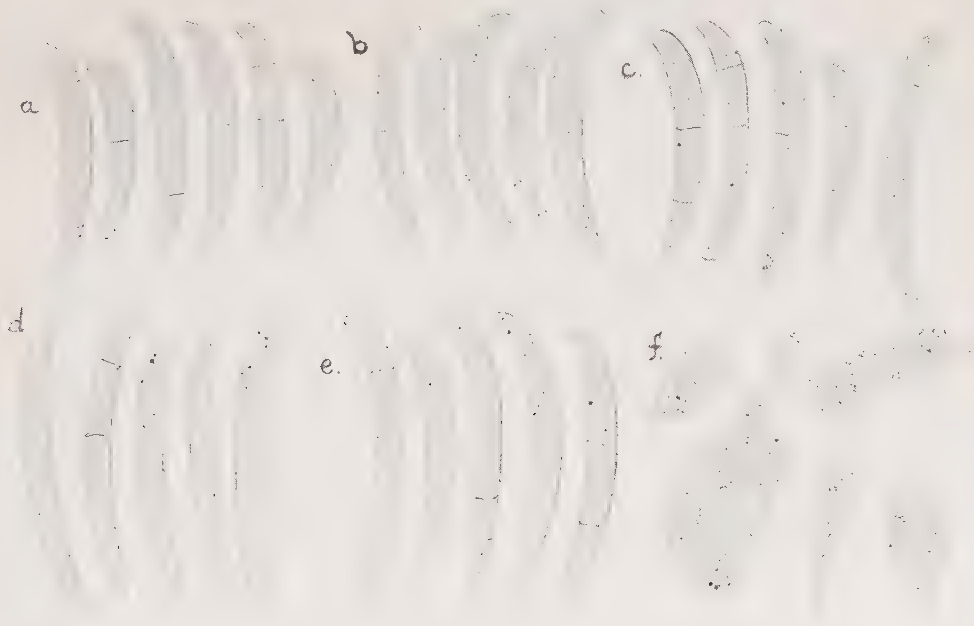

Fig. 47.

Fusarium solani (Mart. pr. p.) App. et. Wr. v. *Martii* (App. et. Wr.) *f.*1 Wr.; conidia from (*a*) sporodochia of 5 weeks old culture on Melilotus stem, (*b*) sporodochia of 10 weeks old culture on potato plug, (*c*) pionnotes of 3 weeks old culture on hard potato agar, (*d*) pionnotes of 4 weeks old culture on oat agar, (*e*) pionnotes of 4 weeks old culture on hard potato agar, (*f*) chlamydospores from 4 weeks old culture on hard potato agar.

Citrus sinensis Osbeck, from bark cracking above union (roots waterlogged) Letaba Estates, N. Transvaal; from bark and wood, Boschrand, E. Transvaal and Elandsdrift, Rustenburg dist. (Turner); from crown, bark and roots of seedling orange, near Klaver,

van Rhynsdorp dist., Cape (Putterill); from roots of old seedling orange with dry root rot lesions, Villiersdorp, Cape, M.H. 28358 and 28361; from bark of navel orange showing gummosis, Frantzina's Rust, E. Transvaal, August 1930 (van der Plank).

On fruit, after 12 to 18 weeks in storage, mostly from stem end occasionally from navel end and lateral lesions; on navel oranges from Sunday's River, Cape, and from White River, Rustenburg and Letaba, Transvaal; also on Valencia oranges from Sunday's River, White River, Zebediela and Rustenburg (23 isolations).

Delphinium sp., from crown of wilting plant, Pretoria (Bottomley) and Qumbu, E. Griqualand.

Lathyrus odoratus L., from stems of yellowing seedlings (Ass. *Pythium* sp.) Brooklyn, Pretoria.

Mathiola incana R. Br., from stems of dying plants, Uitenhage, Sept. 1932 (Wilson); Durban (McClean) M.H. 28365.

Medicago sativa L., from stem of plant with rotting crown, Pietersburg, N. Transvaal (Wager).

Penstemon sp., from stems of wilting plants (ass. *Rhizoctonia*) Pretoria.

Phaseolus acutifolius Gray, from stems of Tepary bean plant, which was also infected with *Colletotrichum* sp., Immerpan, Springbok Flats, Transvaal (Sellschop).

Phaseolus sp., from stems of wilting plants in variety trials, Premier Cotton Estates, Mvamba.

Pisum sativum L., from stems of wilting plants (probably secondary to bacterial infection).

Rheum rhaponticum L., from crown of dying plant, Balfour, Transvaal, March 1930 (Wager) M.H. 28404.

Solanum tuberosum L., from tubers showing dry, sunken, discoloured patches, Belgian Congo; from stems of wilting plants (ass. *F. oxysporum f.* 1) Moorddrift, Transvaal; from stems of etiolated plants in greenhouse, Pretoria.

Nomadacris septemfasciata, on eggs of red locust hatching in sterilised soil, Pretoria' 1932 (Brookes) M.H. 28364.

This form is widely distributed in humus, and on decaying parts of plants, in warm and temperate regions. It is recorded by Reinking and Wollenweber (39 p. 220) on rotted roots of *Citrus aurantifolia* Sw. in Central America.

Growth on Standard Media.

Oat agar : Aerial mycelium sparse, rather coarse, white to cartridge buff, tomentose; or aerial mycelium may be lacking. Pionnotes and groups of sporodochia developed freely, and were at first cartridge buff, becoming pinkish, and, after 8 weeks, sage green to deep grayish blue green.

Hard potato agar : Aerial mycelium not abundant, coarse, short, tomentose. Pionnotes developed along the needle track, and groups of sporodochia at the base of the slant; conidial masses were pinkish buff, becoming tinged deep bluish gray green to deep olive buff; in some tubes they were deep glaucous green.

Standard synthetic agar plus starch : No aerial mycelium. Pionnotes cartridge buff, or tinged grayish olive.

Potato agar plus 5 *per cent. dextrose :* Aerial mycelium short, coarse, tomentose, white to cartridge buff. Growth on substratum onion skin pink to vinaceous tawny or clay colour. Sporodochia pinkish buff, becoming deep olive buff or deep grayish blue green.

Potato plug : Mycelium covering the plug, short, rather coarse, loose, white to cartridge buff, sometimes with patches of dusky dull bluish green and deep delft blue. The plugs early became covered with a mass of closely crowded, pinkish buff sporodochia, which coalesced to form a dense pionnotes. The conidial masses became tinged greenish glaucous blue to dark bluish glaucous, and later Russian green to dusky dull green.

Melilotus stems : Mycelium rather scant, white, tomentose. Sporodochia pinkish buff, becoming tinged sage green.

Bean pod : Mycelium sparse, white, tomentose. Sporodochia and pionnotes pinkish buff, becoming pea green.

Rice : Mycelium white to cartridge buff, mealy, becoming tilleul buff to pinkish buff. Rice grains naples yellow to ochreaceous buff and cinnamon brown. Small sporodochia sometimes developed.

Measurements of Conidia.

Oat agar, culture 4 weeks old, conidia from pionnotes.		
5-septate	0·5 per cent	55 × 5·5.
4-septate	1·5 ,,	51–55 × 5–5·5.
3-septate	72 ,,	32·5–52·5 × 4·4–5, mostly 37·5–45 × 5.
2-septate	3 ,,	32·5–35 × 5.
1-septate	8 ,,	
0-septate	15 ,,	
Hard potato agar, culture 3 weeks old, conidia from pionnotes.		
3-septate	81·5 per cent	30–47·5 × 4–5.
2-septate	5 ,,	25–30 × 4–5.
1-septate	6 ,,	15–25 × 3·2–5.
0-septate	7·5 ,,	5–12·5 × 2·5–5.
Potato plug, culture 4 weeks old, conidia from sporodochia.		
4-septate	2·5 per cent	40–45 × 4·7–5.
3-septate	64 ,,	30–45 × 3·7–5.
2-septate	3·5 ,,	27·5–32·5 × 3·75.
1-septate	2 ,,	
0-septate	28 ,,	
Bean pod, culture 2 weeks old, conidia from sporodochia.		
5-septate	17·5 per cent	40–47·5 × 5–6.
4-septate	50 ,,	35–45 × 4·5–5·5.
3-septate	30 ,,	35–40 × 5–5·5.
2-septate	0·5 ,,	
1-septate	1 ,,	
0-septate	1 ,,	

Fusarium coeruleum (Lib.) Sacc.

Saccardo, Syll. Fung. 4: 705, 1886. Wollenweber, Fus. aut. del. 407–410. Wollenweber and Reinking, Die Fusarien, 134, 1935.

Syn. *Selenosporium coeruleum* Libert in herb.

Fusarium violaceum Fuckel ; F. aeruginosum Del.

FIG. 48.

Fusarium coeruleum (Lib.) Sacc. ; conidia from (*a*) myclium of 8 weeks old culture on Melilotus stem, and (*b*) pionnotes of 6 weeks old culture on oat agar.

Conidia in sporodochia, in extended pionnotal layers, or scattered in the mycelium. Macroconidia almost straight or sub-falcate, with obliquely conical, ellipsoid or rounded apex, and base obtusely oval to mammillate, or with a papilla oblique to the longitudinal axis. Conidia in mass isabellinous-ochraceous to brownish white, sometimes taking a blue-violet to blue-black or wood green tinge from the stroma. Chlamydospores terminal or intercalary, 1-celled, spherical (9 μ) to pear-shaped (9×8) or 2-celled (14×9). Stroma effuse or verrucose, sclerotial, light or violet to blue-black. Conidia mostly 3-septate, less frequently 4–5-septate, exceptionally 0–2- or 6–7-septate.

0-septate............	$16 \times 4{\cdot}7$.	
1-septate............	$21 \times 4{\cdot}7$.	
3-septate............	$21\text{–}47 \times 3{\cdot}5\text{–}6$.......	Mostly $32\text{–}40 \times 4{\cdot}5\text{–}5{\cdot}5$.
5-septate............	$42 \times 5{\cdot}2$.	

Hab. *Solanum tuberosum* L., from tubers showing storage rot in a consignment from Hamburg, Germany, Dec. 1929 (Wager); also isolated by du Plessis (13) from rotting tubers, George, Paarl, Stellenbosch and Ceres, in the winter rainfall area.

No detailed notes were made of the cultural characters and conidial measurements of the strain studied.

ANNOTATED HOST INDEX.

A.—Fusaria on Flowering Plants.

Allium cepa L.

Foot rot, root rot and bulb rot.
- *Fusarium oxysporum f.* 7.
- *F. vasinfectum* v. *zonatum f.* 2.
- *F. moniliforme.*
- *F. bulbigenum.*

Decaying stem tissues.
- *F. scirpi* and *F. scirpi* v. *filiferum.*

Bulb rot in storage.
- *F. moniliforme.*
- *F. solani.*
- *F. solani* v. *Martii f.* 1.

F. oxysporum f. 7 has been found in the Transvaal and in the winter rainfall area (12). The other species, with the exception of *F. solani*, which has been isolated from rotting onions in the Cape Province (11) have, up to the present, only been recorded from the Transvaal; they are, however, cosmopolitan species (25, 61) and are probably more widely distributed than this would indicate.

Ananas comosus Merr.

Fruit rot.
- *Fusarium moniliforme.*

This fungus was isolated from water soaked patches in pineapples; the lesions were more extensive and lighter brown than those caused by *Penicillium* sp. *Fusarium moniliforme* and its variety *subglutinans* have been found in decaying tissues of pineapples in Central America (59, 61).

Andropogon sorghum, see *Sorghum vulgare*.

Antirrhinum majus L.

Decaying stem tissues.

Fusarium oxysporum v. *aurantiacum.*
F. scirpi.
F. scirpi v. *compactum.*

According to Mes (27), the wilt of snapdragons in South Africa is caused by *Phytophthora cactorum ; Fusarium* spp. isolated from badly decayed tissues were not found to be a cause of wilt.

Apple, see *Pyrus.*

Arachis hypogaea L.

Pods and seeds.

Fusarium angustum.
F. oxysporum v. *aurantiacum.*
F. scirpi.

These fungi were isolated from pods and seeds attacked in the soil; the pods from which *F. oxysporum* v. *aurantiacum* was isolated showed a pink discolouration of the shell.

Aster, see *Callistephus.*

Avocado, see *Persea.*

Bean, see *Phaseolus.*

Brachiaria, see *Gramineae.*

Bracken, see *Pteridium.*

Brassica oleracea L.

Decaying stems.

F. oxysporum v. *aurantiacum.*
F. moniliforme.
F. moniliforme v. *subglutinans.*

These fungi were isolated from stems of plants which had been attacked by *Rhizoctonia, Pythium* and aphides; no true cases of "cabbage yellows" have been observed.

Bromus, see *Gramineae.*

Broom corn, see *Sorghum.*

Cabbage, see *Brassica.*

Callistephus chinensis Nees.

Wilted plants.

Fusarium conglutinans v. *callistephi.*

Decaying stems.

F. scirpi.

Aster wilt due to *F. conglutinans* v. *callistephi* is extremely prevalent in South Africa, and was probably introduced with seed imported from overseas. Only wilt-resistant varieties can be grown profitably (53, 55).

Campanula medium L.

Decaying stems.

Fusarium scirpi v. *compactum.*

Canterbury bell, see *Campanula.*

Carica papaya L.

Foot rot.

Fusarium bulbigenum v. *lycopersici.*

F. solani.

F. solani v. *Martii f.* 1.

Fruit rot.

F. lateritium.

F. scirpi.

F. stilboides.

Seedlings damping off.

F. oxysporum.

According to Wager (52), foot rot is caused by *Pythium* spp., and *Fusarium* or *Rhizoctonia* occur as a secondary cause of rot in decaying tissues; inoculations with *Fusarium* spp. did not give rise to foot rot. In Trinidad (2) a *Fusarium* sp. was found to cause a foot rot under moist conditions. *F. diversisporum* and *F. dimerum* v. *pusillum* act as wound parasites of papaw fruit in the Philippines (61).

Carnation, see *Dianthus.*

Centaurea cyanus L.

Discoloured stem tissues.

Fusarium vasinfectum v. *lutulatum.*

F. solani v. *Martii f.* 1.

Citrullus vulgaris Schrad.

Wilting plants.

Fusarium bulbigenum v. *niveum.*

Extensive wilting is reported in commercial plantings of watermelons. Varieties selected in America for wilt resistance (23) have been tested; Iowa Belle Round, Iowa Belle Long, Pride of Muscatine and Iowa King all showed considerable resistance under South African conditions; the highest degree of resistance was shown by Iowa Belle Round. Further variety tests are in progress.

Citrus spp. (**C. grandis** Osb., **C. limonia** Osb., **C. sinensis** Osb.).

Dry root rot.

Fusarium angustum.

F. solani.

F. solani v. *Martii f.* 1.

F. vasinfectum f. 2.

F. scirpi.

Bark on branches and twigs.

F. avenaceum f. 1.

F. lateritium.

F. lateritium v. *longum.*

F. scirpi.

F. scirpi v. *compactum.*

F. semitectum v. *majus.*

F. solani.

F. solani v. *Martii f.* 1.

Buds in nursery stock.

F. lateritium.

Decaying fruit.

F. angustum.
F. bulbigenum v. *lycopersici.*
F. decemcellulare.
F. equiseti.
F. lateritium.
F. lateritium v. *longum.*
F. moniliforme.
F. moniliforme v. *subglutinans.*
F. oxysporum.
F. sambucinum.
F. sambucinum f. 2.
F. scirpi.
F. scirpi v. *compactum.*
F. semitectum v. *majus.*
F. solani v. *Martii f.* 1.
F. stilboides.
F. vasinfectum f. 2.

Fusarium solani and *F. solani* v. *Martii f.* 1 were almost always found associated with dry root rot, frequently in conjunction with *F. angustum* or *F. vasinfectum f.* 2, but are also found on apparently sound roots and in soil in citrus orchards. None of the *Fusarium* spp. isolated from decaying roots was found to be capable of causing dry root rot. Of the species isolated from decaying fruit, *F. lateritium*, *F. moniliforme* plus v. *subglutinans*, *F. oxysporum*, *F. scirpi* plus v. *compactum*, *F. solani* v. *Martii f.* 1 and *F. vasinfectum f.* 2, on inoculation into oranges, produced extensive brown rots readily, if somewhat slowly. *F. lateritium*, *F. oxysporum* and *F. solani* v. *Martii f.* 1 were the most active rot-producing organisms (Plate I, IIa). *F. angustum*, *F. bulbigenum* v. *lycopersici*, *F. lateritium* v. *longum*, F. *sambucinum* plus *f.* 2, *F. semitectum* v. *majus* and F. *stilboides* rarely produced more than small, dry lesions around the point of inoculation. Only negative results were obtained by inoculating *F. decemcellulare* and *F. equiseti* into oranges.

Coffea arabica L.

Stem tissues of unthrifty plants.

Fusarium oxysporum.

Berries.

F. lateritium v. *longum.*
F. stilboides.

It is interesting to note that *F. lateritium* v. *longum* has been found to cause a bark disease of coffee in East Africa (44, 61). It is not known whether this organism occurs on bark in the Northern Transvaal; coffee is not now grown in that area on a commercial scale and few observations have been made.

Coffee, see *Coffea.*

Coral plant, see *Pentstemon.*

Cornflower, see *Centaurea cyanus.*

Cotton, see *Gossypium.*

Crotalaria juncea L.

Stems of wilted plants.

Fusarium sp. (*elegans* section).
F. scirpi.

A *Fusarium* sp. of the *elegans* section (probably belonging to the *F. vasinfectum* series) was isolated from stems of wilting plants of Sunn hemp and has been described. It occurs in Trinidad and India, and on *C. striata* in Uganda (4, 28, 46, 61).

Cucumber, see *Cucumis*.

Cucumis sativus L.
Rotting fruits
Fusarium scirpi.
F. scirpi v. *compactum.*
Stems of wilting plants.
F. equiseti.
F. scirpi.

Several species of *Fusarium* are recorded as causing rot of cucumber in temperate climates; they are wound parasites, namely *F. solani*, *F. orthoceras*, *F. reticulatum* and *F. culmorum* (61). The above-mentioned fungi were found in cucumbers affected with soft rot and leaking, in the sub-tropical conditions of the Eastern Transvaal.

Cucurbita pepo L. and **C. maxima** Duch.
Stems of wilting plants.
Fusarium javanicum.
Decaying stem tissues.
F. solani v. *Martii f.* 1.

Fusarium javanicum causes a foot rot of cucurbits, and is often responsible for serious losses in commercial plantings (9). It has been found occurring on pumpkin, marrow and Hubbard squash in the field. Inoculation experiments resulted in 70 per cent. to 100 per cent. infection of marrow, pumpkin, watermelon, spanspek (*Cucumis melo*) and cucumber plants. In the case of watermelons, a high percentage of plants of varieties resistant to the vascular wilt (*F. bulbigenum* v. *niveum*) succumbed to the attacks of this organism. The "Sugar Through" gourd, and a plant known locally as the "Maraka" (*Cucurbita pepo* var. *verrucosa*) proved to be resistant.

Cupressus lusitanica Mill.
Dying seedlings.
Fusarium oxysporum v. *aurantiacum.*

This fungus is known in Europe and North America as a cause of damping off in coniferous seedlings (61).

Cynodon, see *Gramineae.*

Cypress, see *Cupressus.*

Dahlia pinnata Cav.
Dying seedlings.
Fusarium sp. (*elegans* section).

This fungus was associated with *Rhizoctonia* sp. and *Pythium* sp.

Darnel, see *Gramineae.*

Datura stramonium L.
Stems of wilting plants.
Fusarium sp. (*elegans* section).

Delphinium Ajacis L.

Decaying stem tissues.

Fusarium solani v. *Martii f.* 1.

Dianthus caryophyllus L.

Stems of wilting plants.

Fusarium dianthi.

Foot rot and crown rot.

F. bulbigenum v. *lycopersici.*
F. scirpi.
F. scirpi v. *acuminatum.*
F. semitectum v. *majus.*
F. solani.

Severe losses from carnation wilt are recorded from Natal and the Northern Transvaal (47). The organism found in wilting plants from these areas agrees morphologically with *F. dianthi*, and has been shown to cause wilt in carnation seedlings artificially inoculated. Fungi found in tissues of plants affected with crown rot usually attack carnations growing under unsuitable climatic or cultural conditions.

Digitaria, see *Gramineae.*

Dimorphotheca aurantiaca D.C.

Plants affected by foot rot.

Fusarium sp. *undet.*

Drabok, see *Gramineae.*

Euphorbia crassipes Marloth.

Rotting stems.

Fusarium avenaceum f. 1.
F. lateritium.
F. moniliforme.
F. scirpi.

Fusarium lateritium was also isolated from the fleshy stem of *Euphorbia obesa.*

Fragaria sp.

Foot rot.

Fusarium sp. undet.

In North America and in England, root rot of strawberries is caused by *F. orthoceras* (61) and other species. The African disease needs further study.

Freesia refracta Klatt.

Corms showing dry rot.

Fusarium bulbigenum.

The internal tissues of the corms were light brown, and there was a white, powdery deposit on the exterior of the corms when dry ; a similar rot occurs in America (45).

Geranium, see *Pelargonium.*

Gilia rubra Heller.

Foot rot.

Fusarium solani.
Fusarium sp. undet. (*elegans* section).

A *Pythium* sp. was present in all affected plants, and it is likely that the *Fusarium* spp. were a secondary form of decay.

Gladiolus spp.

Rotting corms.

Fusarium oxysporum v. *gladioli.*

F. bulbigenum.

F. solani.

Fusarium oxysporum v. *gladioli* was isolated from corms and leaf bases of cultivated varieties. The first sign of disease was the browning of the younger leaves; affected plants failed to flower. The corms were firm, but showed a brown discolouration, especially near the base. The organism agrees morphologically with *F. oxysporum* v. *gladioli* (28, 61) but its identity needs confirmation by inoculation experiments. *Fusarium solani* was present in the same corms and was probably a secondary cause of decay. *F. bulbigenum* was isolated from corms of an indigenous species growing in the veld in the northern Transvaal.

Goose grass, see *Gramineae.*

Gossypium sp.

Foot rot.

Fusarium angustum.

F. moniliforme.

Fusarium moniliforme is recorded as a cause of foot rot of cotton in the United States (61). The presence of *F. vasinfectum* in wilted cotton plants in South Africa is unproven, although records exist of the occurrence of a *Fusarium* in the vascular bundles of wilted plants. No opportunity has occurred, during the present investigation, of identifying this organism. Boll rots associated with *Fusarium* spp. have also been observed, but no suitable material has been obtained for investigation during the past few years.

Gramineae.

Foot rot of *Eleusine indica* Gaertn. (goose grass).

Fusarium avenaceum.

F. moniliforme.

Foot rot of *Lolium temulentum* L. (darnel, drabok).

F. culmorum.

Ovaries of grasses infected with smut or ergot.

F. avenaceum f. 1.

F. heterosporum v. *congoense.*

Ovaries of *Brachiaria pubifolia.*

F. chlamydosporum.

Fusarium heterosporum v. *congoense* occurs very commonly, forming a pink incrustation on the ovaries of various grasses, especially when they are infected with smut or ergot; the fungus has been found on the ovaries of *Brachiaria, Bromus, Cynodon, Digitaria, Hyparrhenia, Panicum, Pennisetum, Setaria* and *Sorghum*. *F. avenaceum f.* 1 occurs frequently on ovaries of *Paspalum* spp. which are infected with *Claviceps paspali.*

Grapefruit, see *Citrus.*

Grape vine, see *Vitis.*

Grasses, see *Gramineae.*

Hibiscus sabdariffa L.

Stems of wilting plants.

Fusarium vasinfectum.

Fusarium vasinfectum is reported as a cause of wilt of *Hibiscus cannabinus* in Tanganyika Territory (22) and the same fungus probably causes a wilt of okra, *Hibiscus esculentus* L. (61).

Hubbard squash, see *Cucurbita.*

Hyparrhenia, see *Gramineae.*

Indian sorrel, see *Hibiscus.*

Ipomoea batatas Lam.
Surface rot of tubers.
Fusarium oxysporum.

This fungus was isolated from small, dry, discoloured, somewhat sunken patches on the tubers (18).

Ipomopsis, see *Gilia.*

Kaffir corn, see *Sorghum.*

Kentia sp.
Stem of dying palm.
Fusarium scirpi.

Kniphofia sp.
Capsules.
Fusarium moniliforme v. *subglutinans.*

Lathyrus odoratus L.
Foot rot of seedlings and mature plants.
Fusarium vasinfectum v. *lutulatum.*
Fusarium oxysporum.
F. scirpi.
F. scirpi v. *compactum.*
F. solani v. *Martii f.* 1.

Fusarium vasinfectum v. *lutulatum* was always found in the yellowing and drying stems of affected plants. The other organisms were apparently secondary causes of decay.

Larkspur, see *Delphinium.*

Lemon, see *Citrus.*

Limonium sp.
Foot rot.
Fusarium scirpi.
F. scirpi v. *compactum.*

Lucerne, see *Medicago.*

Lycopersicum esculentum Mill.
Stems of wilting plants.
Fusarium bulbigenum v. *lycopersici.*

Decaying stem tissues.

Fusarium angustum.
F. equiseti.
F. sambucinum.
F. scirpi.
F. vasinfectum v. *zonatum f.* 1.

Discoloured vascular tissue in fruit.

F. bulbigenum v. *lycopersici.*

Rotting fruit.

F. scirpi.

Seed.

Fusarium bulbigenum v. *lycopersici.*
F. equiseti.
F. moniliforme.
F. redolens f. 1.

The wilt caused by *Fusarium bulbigenum* v. *lycopersici* is very prevalent in the tomato growing areas of the eastern Transvaal. A number of varieties selected in America for wilt resistance have been tested and the varieties Stone and Marvel were found the most suitable for Transvaal conditions; further selections are being made from these varieties (49, 50, 51, 54). The organisms found in decaying stem tissues were usually associated with *F. bulbigenum* v. *lycopersici*, with *Rhizoctonia* sp., *Pythium* sp., or with *Bacterium solanacearum*. The rotting organisms entered the fruit through wounds, "blossom end rot," or through cracks at the stem end. *F. scirpi* frequently causes a browning of the core of apparently sound fruit. Several species were isolated from seed offered for sale by local seedsmen; most of this seed is imported from America, and several of the fungi found on the seed are causes of rot in tomato fruit.

Maize, see *Zea*.

Marrow, see *Cucurbita*.

Matthiola incana R. Br.

Stems of yellowing and wilting plants.

Fusarium scirpi.
F. scirpi v. *compactum.*
F. solani v. *Martii f.* 1.
F. vasinfectum f. 2.

Medicago sativa L.

Decaying stem tissues.

Fusarium angustum.
F. solani v. *Martii f.* 1.

These fungi were isolated from decaying tissues of plants affected by crown rot; they were usually plants growing in heavy soil and indiscreetly irrigated. *Neocosmospora vasinfecta* was also obtained from the same source.

Mesembrianthemum sp.

Rotting stems of succulent species.

Fusarium avenaceum f. 1.
F. equiseti v. *bullatum.*
F. vasinfectum f. 2.

Musa Sapientum L.

Fruit.

Fusarium moniliforme.
F. semitectum v. majus.
F. scirpi.

Fusarium monilforme was isolated from the internal tissues of fruit shewing "finger tip rot." Hansford (17a) records finger tip rot of several varieties of banana in Uganda caused by this organism. The other two species mentioned were growing on the surface of the rotting fruit.

Nasturtium, see *Tropaeolum*.

Nicotiana tabacum L.

Dying seedlings.

Fusarium moniliforme.

Stems of wilting plants.

F. oxysporum v. *nicotianae.*
F. bulbigenum.

In several publications, tobacco wilt occurring in the western Transvaal has been attributed to *Fusarium oxysporum* v. *nicotianae*, on account of the presence of a Fusarium mycelium in the vascular system and the similarity of the symptoms to those of the American tobacco wilt (19, 20). During the season 1925–1926, wilt was pronounced in the western Transvaal, probably as a result of spells of hot, dry weather. When wilt is severe, all leaves droop, turn yellow and die within a few days. Often only one lateral root is affected and leaves on that side of the plant alone are affected, the others remaining normal. Wilting is accompanied by a darkening of the wood from the roots upwards. *Fusarium bulbigenum* was isolated as a pure culture from all parts of the discoloured wood—from root to petiole. Its pathogenicity has not yet been proved by inoculation, so that it is not known whether this strain of *F. bulbigenum* is a specific vascular parasite of tobacco. In later publications this fungus is referred to as *Fusarium* sp. (29, 30, 32). More recently a *Fusarium* sp. morphologically identical with *F. oxysporum* v. *nicotianae* was isolated from tobacco plants from the Rustenburg district: this fungus caused wilting in tobacco seedlings after inoculation. The role of *Fusarium* spp. in causing tobacco wilt in South Africa is in need of investigation. The "Kromnek" disease, previously known as the "Kat River wilt," on investigation proves to be a virus disease very similar to spotted wilt of tomatoes, etc. The "wilt" in Turkish tobacco, serious in 1926 in the western Cape Province, was also probably "kromnek" (31).

Onion, see *Allium*.

Orange, see *Citrus*.

Panicum, see *Gramineae*.

Papaver nudicaule L. and **P. Rhoeas** L.

Foot rot.

Fusarium scirpi.
F. scirpi v. *compactum.*

Iceland poppies and Shirley poppies are grown in the Transvaal for winter and early spring flowering. When the temperature rises in the late spring, the leaves often yellow, and the stems rot. The stem tissues are found to be invaded by a *Pythium* sp. and *Rhizoctonia* sp. associated with the Fusaria mentioned above.

Pawpaw, see *Carica*.

Pea, see *Pisum*.

Peach, see *Prunus*.

Peanut, see *Arachis*.

Pelargonium sp.

Rhizome, showing firm, brown type of rot.

Fusarium javanicum v. *radicicola*.

Pennisetum, see *Gramineae*.

Penstemon sp.

Decaying stems.

Fusarium solani v. *Martii f*. 1.

Fusarium sp. undet.

From stems of plants showing foot rot, associated with *Rhizoctonia* sp.

Persea americana Mill.

Roots.

Fusarium moniliforme.

Fusarium sp. undet. (*elegans* section).

These fungi were found in roots of an avocado tree which was dying back from the tips of the branches, and also from the soil of the orchard ; a *Phytophthora* sp. was also isolated.

Phaseolus vulgaris L. and **Ph. acutifolius** Gray v. **latifolius** Freem.

Foot rot.

Fusarium oxysporum v. *aurantiacum*.

F. scirpi v. *acuminatum*.

F. solani.

F. solani v. *Martii f*. 1.

The plants from which these fungi were isolated showed yellowing and wilting of the leaves and stems, but the specific " dry root rot " organism (*F. solani* v. *Martii f*. 3) was not isolated. *F. solani* was found in stems of Tepary bean, the other species were isolated from French bean plants.

Phlox Drummondii Hook.

Foot rot.

Fusarium moniliforme.

F. scirpi.

These fungi were associated with *Rhizoctonia* sp. in the decaying stem tissues.

Physalis angulata.

Wilting stems.

Fusarium sp. undet.

Pineapple, see *Ananas*.

Pinus spp.

Dying seedlings.

Fusarium oxysporum v. *aurantiacum*.

F. scirpi.

Discoloured wood.

F. angustum.

From dying seedlings of *Pinus palustris*, *Pinus taeda* and *P. longifolia* from Zululand and the northern Transvaal. *F. oxysporum* v. *aurantiacum* is known in Europe as a cause of "damping off" in seedlings of Conifers.

Pisum sativum L.

Stems of wilting plants.

Fusarium oxysporum f. 8.
F. vasinfectum v. *lutulatum.*
Fusarium sp. undet. (*elegans* section).
Fusarium moniliforme
Fusarium moniliforme v. *subglutinans.*
F. scirpi.
F. solani v. *Martii f.* 1.

The last four fungi are probably organisms which are saprophytic on decaying stem tissues. Only one set of isolations studied agreed morphologically with *F. oxysporum f.* 8 (48, 61) but a number of strains of Fusaria of the *elegans* section were not obtained in good sporulating condition and could not be identified. The *Fusarium* wilt of peas in this country needs investigation. *Fusarium vasinfectum* v. *lutulatum* was isolated from wilting seedlings, and from plants which did not wilt but failed to set seed. This fungus has been mentioned as a cause of wilt in America (24). For a discussion of the causes of pea wilt in Europe and America, see Wollenweber and Reinking (61).

Polygala virgata.

Stem of wilting plant.

Fusarium angustum.

Poppy, see *Papaver*.

Potato, see *Solanum*.

Prunus persica Sieb. et Zucc.

Rotting fruit.

Fusarium lateritium.
Fusarium sp. undet. (*elegans* section).

The undetermined organism invaded fruit which had been severely attacked by "freckle" (*Cladosporium carpophilum*).

Pteridium aquilinum.

Dying stems.

Fusarium scirpi.

associated with *Pestalotia* sp. and *Pythium* sp.

Pumpkin, see *Cucurbita*.

Pyrus malus L.

Core rot of fruit.

Fusarium moniliforme.
F. moniliforme v. *subglutinans.*
F. scirpi.

In Europe and America, core rot is attributed to *F. avenaceum* and *F. lateritium* and less frequently to *F. oxysporum* v. *aurantiacum* and *F. lactis* (61). The chief cause of core rot in South Africa appears to be *Penicillium expansum*.

Red hot poker, see *Kniphofia*.

Rheum rhaponticum L.

Decaying stems.

Fusarium solani v. *Martii f.* 1.

Fusarium undet. (*elegans* section).

These fungi were found in rhubarb stems which had succumbed to the attack of *Phytophthora parasitica* v. *rhei*.

Rhubarb, see *Rheum*.

Saccharum officinarum L.

Dying leaf.

Fusarium moniliforme v. *subglutinans*.

For a discussion of the diseases caused by *F. moniliforme* and its variety *subglutinans*, see Wollenweber and Reinking (61). The Pokkah-boeng disease of sugar cane has not been observed in Natal.

Sesamum orientale L.

Stems of wilting plants.

Fusarium vasinfectum f. 2.

A wilt of *Sesamum* has been reported from Turkestan, India and Japan, and is attributed to a *Fusarium* sp. morphologically similar to *F. vasinfectum* (61). No infection experiments were carried out with the strain isolated from South African plants.

Setaria, see *Gramineae*.

Snapdragon, see *Antirrhinum*.

Solanum tuberosum L.

Stems of wilted plants and discoloured vascular ring in tubers.

Fusarium oxysporum f. 1.

Black rot of tubers.

F. javanicum v. *radicicola*.

Storage rot of tubers.

F. coeruleum.

F. moniliforme.

F. orthoceras.

F. oxysporum.

F. scirpi.

F. scirpi v. *acuminatum*.

F. solani.

F. solani v. *Martii f.* 1.

Fusarium orthoceras appears to be the organism most commonly causing storage of potato tubers in South Africa. It was found in firm tissues with light brown discolouration, in superficial depressed areas and occasionally in tissues affected with a soft form of rot. For a discussion of *Fusarium* spp. causing wilt and various forms of tuber rot, see Wollenweber and Reinking (61), where an extensive bibliography will also be found.

Sorghum vulgare Pers. v. **caffrorum** (Thun.) Hubb. et Rehder.
Heads moulding in sheath before unfolding.
Fusarium moniliforme.
Pink incrustation on smutted heads.
F. culmorum.
F. heterosporum v. *congoense.*

Sorghum vulgare Pers. v. **technicum** (Koern.) Job.
Stems showing foot rot.
Fusarium moniliforme.

Squash, see *Cucurbita.*

Statice, see *Limonium.*

Stinkblaar, see *Datura.*

Stock, see *Matthiola.*

Strawberry, see *Fragaria.*

Striga lutea Lour.
Stems and roots of dying plants.
Fusarium equiseti.
F. moniliforme.
F. scirpi v. *compactum.*
F. semitectum v. *majus.*
Fusarium sp. undet. (*elegans* section).

The plants from which these fungi were isolated had been treated with a so-called "witchweed eradicator." It was claimed that maize fields treated with this eradicator were cleared of witchweed, which was attacked and killed by a parasitic fungus. Witchweed plants were treated with this preparation, and a percentage succumbed under very humid conditions. No specific organism was found in the affected plants, but the Fusaria named above were isolated, and also species of *Pythium*, *Rhizoctonia* and *Pestalotia*. These fungi are apparently saprophytes, or weak parasites which are only able to attack the plants under very humid conditions.

Sugar cane, see *Saccharum.*

Sunn hemp, see *Crotalaria.*

Sweet pea, see *Lathyrus.*

Sweet potato, see *Ipomoea.*

Sweet sultan, see *Centaurea.*

Tobacco, see *Nicotiana.*

Tomato, see *Lycopersicum.*

Triticum sp.
Foot rot.
Fusarium culmorum.
Stems of plants with blind ears.
F. moniliforme.
Glumes of stunted plants with deformed ears.
F. semitectum v. *majus.*

For a discussion of Fusaria in connection with wheat diseases, and for a bibliography, see Wollenweber and Reinking (61).

Tropaeolum majus L.
Stem of wilting plant.
Fusarium solani.

associated with *Pythium* sp.

Viscaria viscosa Aschers.
Decaying stem tissues.
Fusarium scirpi.

Vitis vinifera L.
Mycelial growth on bark.
Fusarium scirpi v. *acuminatum*.

Watermelon, see *Citrullus*.

Wheat, see *Triticum*.

Witchweed, see *Striga*.

Zea mays L.
Foot rot, root rot, and cob mould.
Fusarium moniliforme.
F. moniliforme v. *subglutinans*.
F. graminearum (*Gibberella saubinetii*).
Decaying stems and roots.
F. solani.
F. scirpi v. *acuminatum*.

Foot rot and cob mould due to *Fusarium* spp. are very common and widespread diseases of maize in South Africa.

B.—Fusaria on Other Fungi.

Hypocreales.

Epichloë Zahlbruckneriana.
Fusarium ciliatum.
F. decemcellulare.

Claviceps spp.
F. avenaceum f. 1.
F. heterosporum v. *congoense*.

Basidiomycetes.

Uredineae.
Puccinia ranulipes.
Fusarium avenaceum.

Ustilagineae.
F. heterosporum v. *congoense*.
F. culmorum.

C.—Fusaria on Insects.

Aspidiotus furcillae (hidden sclae) on *Acacia.*
Fusarium coccophilum.

Aspidiotus perniciosus (pernicious scale) on *Pyrus.*
Fusarium coccophilum.

Aspidiotus rapax (greedy scale) on *Ribes.*
Fusarium coccophilum.

Ceroplastis sp. (waxy scale) on *Acacia.*
Fusarium lateritium.

Chionaspis sp. on indigenous tree.
Fusarium coccophilum.

Chrysomphalus aurantii (red scale) on *Citrus* and *Rosa.*
Fusarium coccophilum.

Glossina sp. (Tsetse fly).
Fusarium semitectum v. *majus.*

Icerya purchasi (Australian bug) on *Mentha.*
Fusarium scirpi.

Lepidosaphes Gloveri (mussel scale) on *Citrus.*
Fusarium coccophilum.
F. sambucinum.
F. sambucinum f. 2.
F. lateritium.

Nomadacris septemfasciata (red locust).
F. sambucinum f. 6.
F. scirpi.
F. scirpi v. *acuminatum.*
F. scirpi v. *filiferum.*
F. semitectum v. *majus.*
F. solani v. *Martii f.* 1.

Fusarium coccophilum occurs very commonly on scale insects in the more humid areas near the south-east coast and in the northern and eastern Transvaal; it is an important factor in reducing scale infestation. It does not occur where humidity is low, and experience in other countries has shown that it is useless to try to introduce the fungus into areas where conditions are unsuitable (35, 60).

D.—Fusaria on Animal Products.

Eggs.
Fusarium moniliforme.
F. semitectum v. *majus.*

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Fxplanation of Plates.

Plate I. Fusarium-rot of oranges, caused by artificial inoculation with (*a*) ***Fusarium*** *lateritium* and (*b*) ***Fusarium*** *solani* var. *Martii f.* 1; photographed in each case about 4 weeks after inoculation.

Plate II. (*a*) Fusarium-rot of orange, caused by artificial inoculation with ***Fusarium*** *oxysporum;* photographed 4 weeks after inoculation.

(*b*) Section through perithecia of *Gibberella Saubinetii*, (× 75).

Plate III. Branch of orange tree infested with red scale, which has been attacked by *Fusarium coccophilum.* (Natural size).

Plate IV. (*a*) Detail from the branch shown in Plate III, showing *F. coccophilum* growing out of the margin of the scale. (× 10).

(*b*) Section through sporodochium of *F. coccophilum,* taken from specimen shown in Pl. 3 (× 150).

INDEX TO SPECIES AND SYNONYMS.

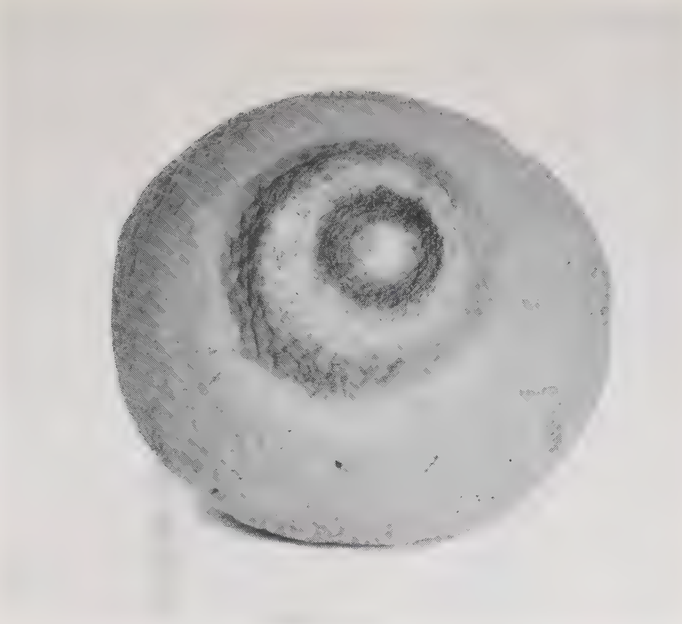
Italicised numbers indicate pages with illustrations.

a.

Plate I.

b.

Plate I.



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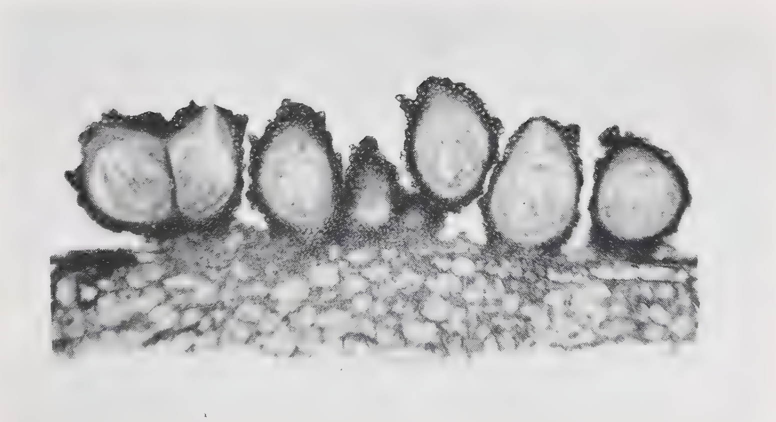
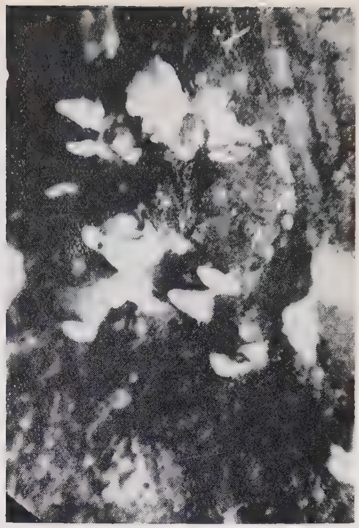


b.

PLATE II.

Plate III.



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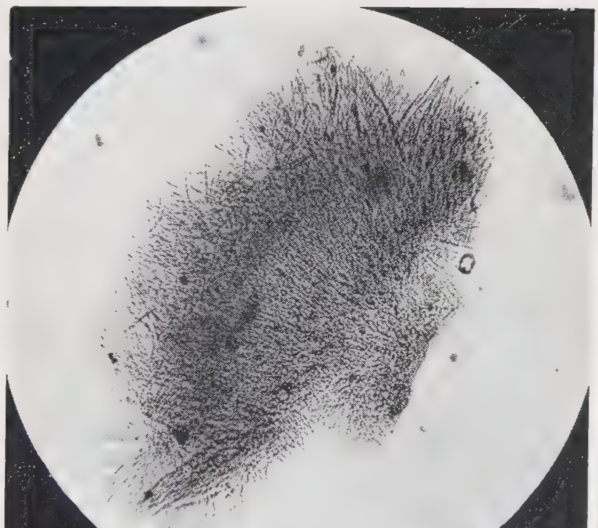

b.

PLATE IV.